

TO

Dr. Arthemy A. Horvath

A SAVANT OF

THE ROCKEFELLER INSTITUTE,

WITH THE COMPLIMENTS OF

Fredrick J. Gates

THE NATURAL HISTORY OF A SAVANT

*Le Savant, from which
this book has been trans-
lated, was first published
in 1923 by Messieurs
Hachette et Cie.
of Paris*

THE
NATURAL HISTORY
OF A SAVANT

By

Prof. CHARLES RICHEL

Membre de l'Institut

TRANSLATED FROM THE FRENCH

By Sir OLIVER LODGE

LONDON AND TORONTO

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TRANSLATOR'S PREFACE

MY eminent friend Charles Richet, Membre de l'Institut, who has recently retired full of honours from his long tenure of the Chair of Physiology in the University of Paris, and who is revered all over the world as a leader and discoverer in his own field, is well known to be a man of letters as well as a man of science. He has perpetrated, among other writings in prose and verse, a sort of Natural History of the Savant; a book which I saw him present, with a few humorous comments, to the Académie des Sciences during a meeting of that branch of the French Institute three years ago.

At the same time he asked me to translate it into English. Not without some unpardonable or, perhaps rather, pardonable delay, I have done so, in the hope that it will amuse and interest readers in English-speaking countries. But I must admit that the original is more racy than my translation, and in so far as I have failed to do justice to his literary style, I must express

regret. I hardly know if style can survive translation. Sometimes a paraphrase would be more telling, but even then something would evaporate, fine shades of meaning would probably be altered; and imitation is never satisfactory. So I just do what I can, and trust that the humour, the liveliness, and the occasional exaggerations of the author will not be completely concealed. Here, for instance, is a sentence, from page 50 of the original, which is not easy of translation:—" Il ne sait pas, malgré toute sa science, que l'opinion de la foule est celle d'une gourgandine menée par une trentaine de malfaiteurs ignorants ": and there are other expressions for which, with no desire to tone down, I may have failed to find any English equivalent.

But apart from all questions of style and humour, Professor Richet undoubtedly had a serious purpose in writing this little book, and it is rather close to his heart that it should be introduced to his numerous friends in this country. It contains some conscious and much unconscious autobiography, and, though intended to influence the leaders of public opinion

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towards a clearer apprehension of the value of science and of scientific workers, it may be welcomed also by students both young and old,—especially, perhaps, in the biological sciences,—as depicting the difficulties and uncertainties, the attempts and failures, through which a discoverer of new facts has to go. Most of the personal examples are naturally taken from savants who have lived in Paris, and some of the traits may be peculiarly French, but it is all the more instructive to be introduced to modes of thought prevalent in another country.

It must not be supposed that I everywhere agree with the author's contentions, for, as he well knows, my philosophy is less materialistic than his own; so we often agree to differ on details, but surely he is entitled to his well-earned and forcibly expressed opinions.

OLIVER LODGE.

Postscript.—The following note extracted from *Nature* for Jan. 15th, 1927, may be of some interest, in relation to the belated spread of scientific education in this country and the training of teachers:—

In 1794, during the French Revolution, the Committee of Public Welfare decided that there should be

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established in Paris a normal school where instruction in the art of teaching science should be given to persons already possessing scientific knowledge. Through this came the foundation of the École Normale, which began its work on January 21st, 1795.

THIS little book is one of a series published by Hachette, in Paris, under the general title, CHARACTERS OF OUR OWN TIME. The series so far announced consists of the following: THE POLITICIAN, by Louis Barthou; THE PEASANT, by Henry Bordeaux; THE PRIEST, by l'Abbé Bremond; THE BOURGEOIS, by Abel Hermant; THE FINANCIER, by R. G. Lévy; THE BUSINESS MAN, by Louis Loucheur; THE AUTHOR, by Pierre Mille; THE DIPLOMAT, by Maurice Paleologue; THE SAVANT, by Prof. Richet; THE LAWYER, by Henri Robert; THE WORKMAN, by Albert Thomas, etc.

Professor Richet's volume on LE SAVANT is dedicated "to the memory of a great savant, my dear and trusted friend, GASTON BONNIER."

THE NATURAL HISTORY
OF A SAVANT

L'Avenir de l'humanité dépend du Savant

Chapter I

WHAT IS A SAVANT?

THE French language nicely discriminates between a savant and a learned professional man. A man may be learned in Astronomy; but if he has some other profession than that of Astronomy—if, for instance, he is a naval officer or a hydrographer—he is not a savant. The English and German languages have no expression for a savant, so that they are often forced to borrow the French term: for *scientist* and *Gelehrter* do not correspond exactly with the word *savant*.

There is only one career compatible with that of a savant, viz. that of a teacher. And, indeed, a savant could not live by his science alone: he would die of cold or hunger. He has to win his daily bread; and this he does by means of his professorship. It is a great fault in our social system that it provides no place for the savant, qua savant. He has to resign himself to being a teacher also. I refrain from commenting here on

this dire necessity: I will speak of it towards the end of the book.

There are many kinds of savants. One variety studies palimpsests, hieroglyphs, extinct languages, ancient histories. As for the writing of modern history, especially of contemporary history, it is not really a matter of science: for in the affairs of our own time, personal appreciation—which has nothing to do with science—holds a preponderating place. The preparation of a treatise on Etruscan origins is the work of a savant, but one need scarcely regard as a savant the historian who recounts such incidents as those of the Treaty of Versailles; which nevertheless is almost as difficult as to descant on the records left by the Etruscans.

Probably the chief characteristic of true savants—whether they be archæologists, mathematicians, chemists, astronomers, or physicists—is that they do not endeavour to apply their work in practice. They are not concerned with the applications of theory. The engineer who designs a ship or a bridge, although he must be very well versed in mathematics, is not a savant, for his object is not the pursuit of unknown

WHAT IS A SAVANT?

truth: he seeks a practical, material and immediate result. Neither is the doctor a savant when he studies the progress of an illness of his patient, nor yet the surgeon who contemplates a grave operation; for they both seek something other than knowledge. To construct a ship, or to save a patient, is to act rather than to think. It is not at all derogatory to say of engineers and surgeons that they are not savants. They may be very learned, but in so far as they have some other object than the discovery of truth, they are not following the career of savants, but of engineers and surgeons. These fine shades are a little delicate; and yet after ripe reflection one recognizes the reality of these fine shades. Besides, what does it matter? Great scientific discoveries are not necessarily due to savants. Far from it. Laennec was not a savant; nevertheless he discovered the process of auscultation. It does, however, sometimes happen that a savant makes an important discovery in other domains than his own. Pasteur was a mineralogist: yet he did more for medicine in twenty years than the most skilful physicians had been able to do in twenty centuries.

Chapter II

VIRTUES AND VICES OF SAVANTS

YOU may be surprised if I say that savants are of the same flesh and blood as other mortals, neither better nor worse. There are some who are marvellously intelligent, others who are almost stupid; some who are greedy, others who are prodigal. Some are chaste, others debauchees. Some are pugnacious, others pacific; some voluble, others silent. There are joyful savants and melancholy savants. It is almost impossible to assign to them any specific character.

Moreover, different sciences exercise different kinds of discipline on their followers, and thus influence their mode of life. This one is plunged deeply into the abstractions of mathematics. Another is a geologist who breaks stones and studies mountain chains. The chemist shuts himself up in his laboratory, distilling, weighing, crystallizing, filtering. The physiologist surrounds himself with bad-smelling and squeaking

animals, mixes them doses of sugar and nitrogen, measures their arterial pressures, and supervises the diet of guinea-pigs. The botanist rambles through fields and forests collecting his plants; and later, his eyes glued to a microscope, seeks to penetrate the mystery of the cell. The astronomer buries himself in columns and pages of figures. The paleographer sets himself to decipher illegible parchments.

The diversity of these occupations and pre-occupations, so different one from another, hinders us from readily recognizing any common attribute in men so diverse. Nevertheless, without too subtle an analysis, the conclusion is finally arrived at that they share one common attribute—a very noble one. Whether they be young or old, French, American, Italian, English, or German; whether they be eloquent or prosy, rich or poor, celibate or married, hungry for praise or despising their critics—yet they all, in different degrees, possess that rare and superb virtue which we call disinterestedness. Not that there have never been savants who seek for gain, who are thirsty for money and honours. Such exist, and will con-

tinue to exist. They are men, and consequently no human defects are foreign to them; but as a class they are exceptionally free from covetousness and greed. And so, in spite of their defects and their vices, all savants have approximately the same kind of soul. They all cultivate truth for its own sake. Science is for them a religion.

However different among themselves fervent Catholics may be, they are all animated by a common feeling, the adoration of Jesus Christ and submission to the Church. So also, however different savants are from one another, they too are animated by a common thought, love of the truth hidden in phenomena. It is not with the object of acquiring an income, honours, or a Chair at a University, that a savant toils for days, months and years. Rather it is because he sees before him problems to be resolved, of which the solution may possibly be sublime. He conceives that by his work and his talent he may perhaps discover what no one has discovered before—a new fact, an unexpected law, an unforeseen relation, the elucidation of some phenomenon hitherto not understood. And this hope, so often delusive, sustains and protects

him. Just as an explorer buries himself in a dark continent with no other thought than of just going on; so the savant, be he great or small, confronted with innumerable mysteries which seem to bar the path of human intelligence, has no other thought but just that of going on.

Without the least desire for gain, savants consecrate their energies to the search for truth. And that is fine. That it is which separates them from the rest of humanity, placing them conspicuously apart.

Disinterestedness! In the midst of our venal society it is almost a miracle. Why does a young man of twenty say to himself, "I want to be a savant." Does he not know that he will never thus attain the joys which luxury affords? His lot, even if he succeeds, will only be a lean living—a bare subsistence; nevertheless he makes up his mind. His choice will involve passing difficult examinations, triumphing over competitors as skilled, as deserving, and as hard-working as himself. He will have to work in an obscure laboratory. Poor he entered into life: poor he will remain. No matter; he loves his science. He determines to be a savant.

Alas! It is the poor who resign themselves to the poverty of the savant. I state this sad and bitter fact. When it becomes a question of a scientific career, young men of property, heirs of a family, say, "It is too difficult; besides it doesn't pay well enough." They never consent, or hardly ever (for there are admirable exceptions), to subject their glorious youth to the hard apprenticeship of the savant. They prefer to be lazy, to lounge in their clubs, or enter some financial company. Commerce, cattle-breeding, the Army, the Navy, diplomacy, the bar, medicine, politics—anything rather than science. Science! How horrible! It is not a career: it is madness, almost a disgrace! Think of it. I, the son of a rich banker, or the son of a landed proprietor, looking down a microscope, weighing crystals, scraping bones, distilling nauseous liquids; and doing it without any hope of escaping from this necessity all my life, doing all this in order that finally—if after great suffering I manage to pass all my examinations brilliantly—I may succeed in earning, perhaps, £600 a year. No, such a fatiguing and poverty-stricken career must be left to

the poor devils who have no influence at their backs.

Such is the state of mind, at least in France, of the rich young man to-day. I have no anger for them, no indignation, but boundless pity for a stupidity so immense that one can only greet it with a regretful smile. For it is the most colossal stupidity. A very rich young man, if at all industrious, and of reasonable intelligence, might give himself the luxury of being a savant; that is, of leading an existence which is not only agreeable, but also useful and even glorious. He would have independence, divine independence. He would live in the hope of making a discovery, a hope which in itself is almost happiness. And every research would be to him relatively easy, for he could use his wealth for scientific work, rather than squandering it in neckties, strings of pearls, race-horses, and automobiles. But rich young men care for science about as much as urchins care for impositions.

Savants are workers. There are some who are idle, but it is rather rare. Perhaps some, towards the end of their days, have less energy

than in the heyday of their youth. But, in general, sloth, that destructive and frequent vice, is exceptional amongst savants. Nevertheless, there are differences in the ardour with which they work: for it is with inertia as with memory. One may have a good memory for certain things but a poor memory for other things—a memory for music, for figures, for poetry, for faces, for places, for events, for arguments—one may be admirably equipped with one of these memories, but deplorably lacking in other kinds. So in the matter of laziness there are analogous differences. Certain savants are extremely lazy about their correspondence, or are very bored by society, though they retain their zeal for new experiments. Some enter with ardour into bibliographical researches who would never dream of undertaking a quantitative analysis. In fact, one may be lazy about certain experiments, and yet industrious about others. In other words, there are specializations in activity as there are in indolence. Some savants—and not a few either—are very lazy when they ought to write an article or a book; though in truth they are not

really lazy. They will work vigorously, almost passionately, all day long: but to take up a pen—to edit, classify, rectify, and correct—this is too heavy a burden. So they accumulate unpublished facts, sometimes of real interest, because they will not go through the little extra labour necessary for putting them in order and making them known.

But if there are a few exceptions to the disinterestedness and activity of savants, there are none to their faith in science. All savants believe in their own science and in science in general. They would willingly write Science with a big S. They have a naïve and robust trust in it which nothing can shake. It is true they sometimes amuse themselves, *inter pocula*—for everything may happen—by exhibiting some cynicism: but on that particular occasion they are not sincere. All, without a single exception, believe in the sovereignty of science; which, like the grammar of Martine, rules even over kings, and imperiously subjects them to its laws.

No doubt they have political opinions, but they rarely enter into the political arena. Indeed, they sometimes exercise their caustic humour—

when they have humour, which is not rare—against colleagues so imprudent as to wander into the electoral morass.

They detest and despise the pseudo-scientific articles which appear in the daily press; for our thought is so imperfectly presented, praised or criticized, *à tort et à travers*, in the morning and evening papers, that the only plan, if we wish to see anything stated exactly, is to hand to the journalist a written copy. The journalist is delighted, for it is ready-made copy; and the savant has the mild satisfaction of finding his thought truly represented without alteration. As a general rule, scientists love neither politicians nor journalists. It is an aversion accompanied by an enormous distrust. Shall we dare to say that they are wrong?

All religious opinions are represented among savants. One finds Catholics, Jews, Protestants, Freethinkers. But there is never in any laboratory a dispute about religion: at least not in Paris; one is told that in the provinces it is not altogether quite the same, but this is outside my knowledge.

Savants are very independent in thought; and

this again is one of their characteristics. They do not accept any yoke. Circulars sent to them by officials are not merely ignored, they are criticized, scoffed at, and then torn up. Savants, are, as is only proper for Frenchmen and investigators, prodigiously individualistic. I am assured that in Germany, on the contrary, they are of a uniform docility. Is this praise? Is it calumny? Is it even true? Very probably not. Truth to tell, the exaggerated individualism of French savants is not without its drawbacks. For it prevents their taking part in team-work or in associations. They do not like collective demonstrations: they keep themselves aloof from any kind of manifesto.

Moreover, they are not very rigid observers of all the duties of a professor—examinations, committees, lectures, council meetings. They delay as long as they can the moment when their courses begin again after the vacation: and they hasten the end as far as decency permits. But let us not be indignant: for this is the business of the teacher, not of the savant. It is a result of the vexatious confusion between two such different functions. For teachers

there must needs be subordination, programmes, discipline. They have to follow traditions, obey rules, listen to injunctions from the dean and the rector. But the savant has nothing to do with that kind of thing. Leave him his proud and fruitful independence. It is a dangerous absurdity to reproach a savant for lack of discipline.

In general, they are absolutely honest, with an honesty beyond what is found in other professions. Not only do they not seek for money, but they even have some fear of it. Financial transactions frighten them. Rarely—in fact, never—do they become rich. In taking up the career of the savant, they have accepted, for their whole life, a modest subsistence.

Great as is their honesty in financial dealings, it is, if possible, still greater in scientific matters. I never knew a single savant who possessed the odious courage to falsify an experiment. They even push conscientiousness to such a degree that they go through their calculations over and over again, write and re-write their papers in order to ensure that they have made no mistake. Their scientific probity is often put to a rude

test: for if a first fine experiment has succeeded it is very difficult to recognize or admit that a second attempt has failed. Yet if it really has failed, failure must be confessed; and they confess it. Or else they hold their tongues and keep silent about their first experiment, which nevertheless had raised high their hopes.

I often recall to my students the history of Don Quixote, who, having constructed a helmet of cardboard and wood, wished to prove its solidity. Alas, the poor helmet flew to bits when his own good sword struck it. Then the knight, no whit discouraged, made a new and stronger helmet. He raised his sword. "No," said he, "I will not smite it; my helmet might perhaps be broken." Let us not imitate Don Quixote. Let us not fear to submit our helmet (whether of theory or experiment) to two, three, or even six tests, and perhaps more.

Disinterested, laborious, loyal, proud, and independent—surely these are splendid traits for our admiration. Shall we not add some shades to the picture? Alas, yes, there are shadows: but they are not very black. Nevertheless, one must have the courage to display them. So I say,

without any hesitation, that savants are unhealthily sensitive, as sensitive as a violinist, or a tenor. If a man has written a book on chemistry, don't go and tell him that in his fine book organic chemistry is admirably dealt with but that there are some little lapses in the treatment of the inorganic variety. That would be fatal, and he would not forgive you. He takes note of all that is said about him; he collects the casual remarks of students and colleagues. He hears that Professor X. has expressed a piquant criticism, rather witty, but malicious. That is enough. Professor X. has become his personal enemy.

Still more so, if instead of an imprudent word, perhaps incorrectly reported, he finds a printed criticism or an unwelcome observation made in the course of a scientific discussion. One day, very long ago, at the Biological Society, a colleague, criticising a communication that I had just made, affirmed that he did not believe a single word of what I had just put forward. "But, my dear confrères," I responded, "what Monsieur S. believes or does not believe about it is not of the smallest consequence: all we

want to know is if it be true or false." As a matter of fact, what I said turned out to be perfectly correct; but S. never pardoned me for my innocent retort.

Formerly, there used to be actual discussions, at the Biological Society, at the Academy of Medicine, even at the Académie des Sciences. To-day this custom has disappeared, and it is a pity. All that goes on is a dry presentation of notes that one can read some days later in the *Comptes rendus*. The meetings are not vivacious or animated, as when a flagrant contradiction puts two opinions in opposition and when the sustainers of one or the other side engage in an oratorical joust. Controversy of this kind can be both instructive and fertile, and occasionally stimulating, for some savants are skilled orators.

Savants are not only touchy: they are jealous, too. For they are men, and cannot look with satisfaction on the honours, decorations, titles, privileges, which fall thick as hail upon some colleague. The closer the science which this colleague cultivates to that which he himself professes, the more bitter is the jealousy. An astronomer is not saddened by the honours

conferred on a botanist, but he might find little justification for those which another astronomer obtains. And in an assembly of professors and savants, when some financial grant is made to a laboratory, at once all the other colleagues protest noisily. I do not think that an example to the contrary can be cited. Suppose three thousand francs or so is given to the laboratory of Inorganic Chemistry. Well! What about Organic Chemistry? And Physiology? And Botany? And Zoology? And Physics? And Mechanics? And Geology? Jealous claims like these are after all legitimate. The zoologist feels he has a mission to defend Zoology; the botanist, to defend Botany. They have faith in their science: they do not wish it treated as a negligible quantity.

I said just now that savants were disinterested: and they certainly are, but not when it is a question of allowances for their laboratories. In that matter they are greedy and intractable, finding the funds always insufficient for their needs, continually asking the dean, the rector, the Minister—which, of course, means finally the poor taxpayer—for additional allowances.

They are right. They know full well the services that can be rendered by their science, and they justly hold that people can never do enough for science. Certainly they are right. One can only progress in the sciences—with the exception of Mathematics—at the price of great pecuniary sacrifice. All apparatus is costly; for as progress is made, instruments become more and more intricate. But what does it matter? No other expenditure could bring equal glory and profit to our native land.

Susceptible, distrustful, jealous—savants in general are endowed with no small share of vanity. One of them, and not the least famous, said to us one day, with the most naïve and charming conviction: “It has always grieved me that I have never known how to appreciate adequately the value of my own work.”

Modesty is a fault which is almost completely lacking in savants. And that is as it should be. What should we do if the savant began to have doubts about his own intelligence? Timidity would paralyse all progress. It is essential for him to have faith not only in science itself, but in his own scientific work. He must not believe

himself infallible, but when he experiments and when he argues, he must have complete confidence in his intellectual powers.

There was published in *L'Illustration* an admirable photograph of Chevreul, the celebrated chemist who died at the age of 103. And underneath, as an epitaph, was written: "Malebranche said: 'aim at infallibility without claiming it. I have found no better rule.'" The fact is that these words indicate a wonderfully sound policy.

This confidence, which is the very opposite of modesty, shows itself also in the conversation of savants. They rarely admit that they are mistaken . . . and yet. . . . In this respect, as in many others, savants resemble artists; and, in fact, they are artists, in their way. In short, they are idealists, though they study the changes of matter. Idealists, because, freeing themselves from the cares of this life, they seek to discover, even in gross matter, the profound, inexorable and sublime laws which regulate the universe. The mysteries of matter are not less than those of spirit.

Thus we often see that certain savants, in

spite of their merit, their virtue, and their genius, will sometimes do the most ridiculous things and commit grave errors. Yet, everything considered, savants represent the noblest part of the human race. They are not gods, and there are gaps in their armour; but they are without hatred and without greed. They love beauty, justice, and truth. They know that perhaps, thanks to them, some light may appear on the crests of the gloomy ocean in which humanity confusedly struggles. And all savants, all without exception, are buoyed up in their efforts by the magnificent hope that they may be useful to their fellow-men.

Jeer at savants: sometimes they deserve it. But take care: behind them stands truth. Truth, the goddess, the sovereign, the all-powerful, who will freeze with terror those who jeer at her!

Chapter III

SOME CHARACTERISTICS OF SAVANTS

THE savants of each country have characteristic features. In Germany, in Scandinavia, in Holland, in Russia, they are so narrowly specialized, almost fossilized, in their work, that they have practically lost contact with the outer world. They are uncouth and rather awkward in their manners; but they make up for this lack of polish by the simplicity and affability of their behaviour.

Alas! that ferocious nationalism which has led the German nation astray and brought it to the depths, has also caused to disappear from Germany that old *Gemüthlichkeit* which had a certain charm; so that the German savants have acquired—so they tell me in various quarters—the bluff manners of the unintellectual Prussians. If so, more's the pity.

The savants of America and England certainly do not lack simplicity and affability; but,

in addition to that, they are men of the world and know how to play their part in society.

In France and in Italy it is quite different. The professional bent (*pli professionnel*) is never absent. He would indeed be a poor observer who could not distinguish between meetings of diplomats, of officers, and of savants. Their conversation is not very interesting—with exceptions, of course. They are timid, and do not speak with animation except on questions they have studied. Their dress is respectable but neglected, for they don't bother about it. They never dogmatize. They hesitate to express definite opinions. Scientific doubt is a first-class quality, but it rather eliminates piquancy from controversy.

And then they are but little versed in ordinary every-day gossip, scandal, yarns, anecdotes, and all the rest of the foolishness that make up the usual topics of conversation. They like to discuss general questions, even though abstractions are quite beyond ordinary people. They are often absent-minded, inattentive, silent; not loquacious even when they are drawn to speak upon their own particular subject. They rather avoid

society, where they bore and are bored. But there are many exceptions.*

Their homes are modest, in conformity with their slender means. In Paris they nearly all live in the *quartier des Écoles*, mostly in the Vth and VIth districts. They go sometimes as far as the VIIth and XIVth, but rarely beyond that.†

Savants like books; but they are rarely bibliophiles. Their library is an instrument for their work, nothing more, but an instrument that they love and respect. Sometimes they are even proud of it; for they have chosen books which are useful to them, and sometimes they are inclined to exaggerate this usefulness.

In order to arrange the memoirs and separate reprints and innumerable brochures that are sent them from various parts of the world they have special and sometimes fantastic classifica-

* To all the assertions I make, brilliant exceptions can always be found.

† Here is a short table of the Parisian *arrondissements* in which those savants live who are members of the Institute :

V	19
VI	16
VII	6
XIV	5

There are only four in the sixteen other divisions of Paris.

tions, known to themselves alone—catalogues which become undecipherable after their death, so that all this organization disappears with them. But no matter, it has served their turn. The disorder of their library is more apparent than real.

In general, they like complete sets, which are ranged in long rows upon almost inaccessible shelves. They are rarely used, but it is a great pleasure just to possess them.

The librarians of big libraries have often made this curious and rather paradoxical remark, that the greatest borrowers of books are on the whole the savants whose own library is best stocked. Yet it is easily explained; those who do not possess books do not care much about them.

A strange fact, and a rather sad one, is that in general savants have only adopted their noble calling of savant by chance. Rarely as school-boys have they felt drawn to the vocation of a savant; for it is not a very definite career. When it is necessary for a boy to choose a profession, he says to himself, "I will be an engineer, or a doctor, or a lawyer, or an officer, or a teacher"; but very rarely does he say "I will devote my-

self to pure science." Later on, if in the course of his studies he grows to love one of the sciences with which he makes acquaintance, then he can abandon himself to it. Guided by chance, rather than by his own wish, he becomes a geologist, a botanist, a chemist, a physiologist, or a mathematician. Though, indeed, the aptitude for mathematics appears early. But among the young men specially gifted for mathematics, how few, alas, become great savants!

Chapter IV

THE WIVES OF SAVANTS

I MEAN, of course, their legitimate wives, for we are not going to assume that there are any others.

They are very different; those of France and those of other countries; those of Paris and those of the provinces. Like their husbands, they have no outstanding characteristics. In general they lead an unworldly and exemplary life, occupying themselves exclusively with their home and their children. They have no history, no past. They rarely interfere in the work of their husbands, and, even when not quite ignorant of it, they pretend to understand nothing about it—which is generally true. Yet in the case of a hotly-contested candidature, they come out of their shell, finding excellent arguments, not scientific but certainly powerful, in support of their husbands, and they rail and storm against his rival.

It is possible, it is even probable, that in the life of the home there are frequent conflicts

between the wife and the laboratory. But one doesn't hear much about them, for the savant never willingly speaks of his wife. I have often heard this unanswerable dilemma: "Of one's wife one can only speak either good or evil. It is ridiculous to speak good of her; odious to speak evil. It is much better to say nothing at all."

We rarely even know whether a colleague is married: his family life does not interest us. It may not be so in the provinces; but in Paris a water-tight partition separates family life from life in the laboratory.

We must admit that it requires plenty of courage to be the wife of a savant; for her rôle is to be negative, which is never agreeable. Her husband can hardly give her the luxury and splendour that follow in the wake of other professions; and the study of science has become too difficult for a woman to have the great intellectual joy of interesting herself competently in the work which occupies her life's partner.

The wife of a savant rather effaces herself before the men students, but much less so before the women students; for nowadays there is

scarcely a professor who has not girls or young women in his laboratory or following his lectures. The wife does not conceal her ill-will towards these dangerous people, and—not unreasonably—she keeps her eye on them.

As to the *amours* of savants, my witty friend, M. de Fleury, has written a clever book under this title: but he writes rather of medical students and doctors than of savants. And then again the love of which he writes is for the most part not true love at all, but a passing fancy.

I am inclined to think that in their love-affairs, savants are very much like other men.

Chapter V

ACADEMIC CANDIDATURE

SOMETIMES, if not always, savants have academic ambitions; and then they lose all sense of proportion. They allow themselves to be carried away by fears or by hopes as commonplace as they are chimerical. They exhaust themselves in irksome visits, harass the electors, recommend themselves confusedly, soliciting the support even of those who have no influence (*que peut apporter "le batard de leur apothicaire."*). They reckon up their votes, make out lists, and over-estimate their slender chances. Science hides her face from it all; but mercifully pardons her erring children, knowing that this is but a passing phase.

It is more excusable when savants are ardent in their candidature for a professorial chair than when they are applying for some minor post; for a chair means a laboratory, that is to say, an almost indispensable means of working, a necessary livelihood also perhaps, and an

assured future; while an academic appointment may be nothing more than a title.

In any case, anybody who wishes to become a member of an Academy must call on Academicians. It is an ancient custom, and although I have suffered both as candidate and as elector, yet this old custom, so much scoffed at, seems to me perfectly justifiable. Before voting for a gentleman who wishes to enter our company, it is only natural that I should want to know about his literary cultivation, the shrewdness of his wit, the correctness of his manner, and even the tone of his voice. One does not pass judgment without hearing counsel, and in an election each candidate is counsel for his own case.

If I were drawing up statistics, I should reckon thus:—every year, in a faculty, an academy, a school, there are about four places to fill, and for each place four candidates. If each candidate pays two visits to each elector, the total is about 2,000 visits at a distance of say two kilometres, which makes 4,000 kilometres. Now there are several academies, several faculties, the Museum, the Collège de France, the School of Mines, the Agricultural

Institute, and the Polytechnic School. So, reckoning them all, there are not far off 20,000 miles to be travelled each year by the candidates.

There is notable contrast between the different apartments which a candidate on his visits has to enter; sometimes a luxurious mansion, almost a palace; sometimes a little retreat at the top of a dark staircase, almost a student's den. Occasionally it is a laboratory. Often it is a public building, the headquarters of an Official, majestic and solemn.

The candidate is always well received. Nothing is more false than the legend that he is liable to be affronted. Rather he receives too many compliments. The elector has not forgotten that he too in his time, like the candidate seated before him, had to submit to this fatuous formality; and old memories make him indulgent.

A dialogue of this sort ensues:

THE CANDIDATE. You will forgive me, Professor, for troubling you in the midst of your work. I have come to pay you the customary candidate's visit. I am an applicant for the Chair of Palæontology at the Collège de France.

ACADEMIC CANDIDATURE

THE ELECTOR. Yes, we have lost our poor Ramponneau, a man eminent in every way. But let us talk about yourself. I know that you have much important work to your credit. When will the election take place?

THE CANDIDATE. That will depend on you more than on me, Professor. . . . I brought with me my list of qualifications.

THE ELECTOR (looking through the papers). Thank you. I see that you have done a lot of work! I am not very competent to judge, for I am busy with Oriental languages, but I know that Palæontology is a very noble science.

THE CANDIDATE. Has not my chief, M. Simonide, your colleague, mentioned my name?

THE ELECTOR. Certainly. He praised you highly, and the opinion of M. Simonide will have great weight with me in my decision.

THE CANDIDATE. Then can I hope for your vote?

THE ELECTOR. I can make no formal promise; it will be necessary to attend the conference and the election. But my sympathy for you is very great. Who are your

competitors? Are their chances as good as yours?

CANDIDATE. Well, no, I don't think they are.

THE ELECTOR. Yet your rival, M. Lhuillier, claims that he has already secured 31 votes: and a majority is only 24.

THE CANDIDATE (trying to recover himself). M. Lhuillier has many illusions.

THE ELECTOR. He has published a great book on the higher Cretaceous Arachnida. He brought it me yesterday. Here it is.

THE CANDIDATE. Oh, I do not doubt its merit. But may I remind you that my memoir on the Liassic Orthoptera, of which I will bring you a copy, has been accepted by the Academy. Besides, M. Lhuillier exaggerates in thinking that the higher Cretaceous Arachnida are characteristic.

THE ELECTOR. I shall be pleased to receive your book . . . but Lhuillier is strongly supported by my colleague Bourgues, professor of Hebrew.

THE CANDIDATE (rising and visibly saddened). I am afraid, Professor, I am wasting

your time which is so precious. I thank you for your great kindness.

THE ELECTOR. It is a pleasure. If you are elected, nobody will be better pleased than myself at your election. Your place is certainly at the Collège de France. . . . Leave me your recommendations. . . . I promise to go through them carefully, ignoramus that I am in Palæontology.

THE CANDIDATE (delighted). Oh! you will be so good. . . .

THE ELECTOR. Certainly. . . . I only wish to decide when I am in full knowledge of the facts. . . .

THE CANDIDATE. Oh! Professor, I ask no more than that, and I am sure that if you judge after reading the recommendations. . . .

THE ELECTOR. Good-bye, my dear sir—soon my dear colleague. Good-bye and good luck.

Chapter VI

VARIOUS WAYS OF BEING A SAVANT

THERE are several kinds of savant: the inventor, the technical expert, the scholar, the professor. It is the harmonious fusion of these various aptitudes that constitutes the great savant; but it is scarcely probable that they can all be united in one person, he nearly always has excess of one or lack of others.

A. *Originality or Inventiveness.*

Originality is the chief virtue.

To have ideas that other men have not had; to imagine unforeseen consequences; to start a new experiment; to repeat an old experiment in order to discover unexpected meanings—that is almost divine! In the history of science, nobody has left his mark on the world unless he has been, in this sense, an innovator.

Yes, originality is the chief virtue.

The gift for investigation appears at an early age: *the demon of research* speaks to men whilst

they are still young. Occasionally it makes them propose absurdities, and exhaust themselves in sterile efforts. All the same, in order that later on he may be a creator, it is necessary that the great savant should in his youth conceive audaciously impossible and incoherent things. He will grow wiser later on. Xenophon had two disciples: "One of them," he said, "needs the bit, and the other the spur." For myself I prefer pupils who need the bit.

The necessary brake for inventiveness is the critical faculty. The innovator who cannot criticize himself severely will promulgate nothing but absurdities. After all, when one declares a new fact, one is always sure of meeting objections and contradictions. Then is it not much better to supply this criticism oneself, rather than to leave it to rivals, to enemies perhaps, certainly to people who are indifferent? That the inventor or discoverer should be enamoured of his experiment, is perfectly just; but let him only accord it his love in good earnest when he has proved its soundness.

In any case he must have tremendous perseverance, for too often discoverers lack the

necessary tenacity. They are so full of ideas that they cannot concentrate their efforts on one of them. The inventive faculty without perseverance can never lead very far.

Pasteur, Claude Bernard, Berthelot, Marey, who were great discoverers, were equipped with the most admirable pertinacity.

Pasteur, after having studied the fermentation of tartrates, attacked lactic fermentation. He was bent upon proving that some infinitely minute organisms—which were not then called microbes—played a preponderating part in chemical actions, in vital functions, in pathological phenomena. It was in this way that he succeeded in constructing the magnificent edifice of medicine and of modern surgery.

Claude Bernard was no less tenacious. Whilst still young, he tried exact processes for estimating the proportion of sugar in tissues. That was in 1843. And the last paper he wrote, a paper which was only published after his death in 1878, was still on the right proportion of sugar.

Berthelot, after having initiated the fundamental experiments of thermochemistry, for thirty years followed all its ramifications without

losing his ardour, continuing the perfection of their technique, and attending to every detail of their application.

And Marey! Marey, who was almost the inventor of the graphic method, remained fiercely faithful to it up to his last breath.

It is therefore only by stubbornness, tenacity, almost obsession, that discoverers and inventors succeed in bringing their work to fruition. Yet perseverance should not be blind obstinacy. Some savants have occasionally wasted their energies for many years on some commonplace matter which had no future. . . .

B. *Technique.*

The technician or technical expert is also a discoverer, a discoverer of trifles. He is interested in the details of apparatus rather than in a theory. He carries his study of the rigorous conditions of an experiment into minutia: he is ingenious at thinking out new modifications. And this is necessary in order to be a skilful persevering experimenter. Lavoisier, the greatest name in all science, made his own furnaces, his balances, his thermometers, his calorimeters.

Regnault belonged to the technician type. He had a passion for the millimetre of mercury. I could cite an eminent physicist who spent two years of his life in constructing an absolutely flawless stopcock.

Generally speaking, an invention, to produce its full results, requires an irreproachable technique laboriously attained. But this does not mean that the technician must immerse himself in details to such an extent as to regard his instruments as anything but as a means to an end. The aim of science is knowledge about phenomena. An instrument, however perfect it may be, is only an instrument. To take a concrete example, let us suppose that a physiologist, who is also a skilful physicist, has constructed an excellent calorimeter, as precise as Atwater's but more manageable. What he has done, after all, is only a preparation for experiment. It is a preamble, a preface. A calorimeter must be used for the study of calorimetry. If it is not used, what good is it? The great physicist, of whom I have just spoken, who, with six diligent students expended two whole years in making sure of the trustworthiness of his vacuum vessels, employed

his perfected stopcock in the study of liquefied gases, and was then led on to experiments both ingenious and profound. His technical skill allowed his inventive genius to develop.

C. *Erudition.*

The learned investigator only experiments after having read nearly everything that is known about the question. Before undertaking a piece of work, he wishes to know all that has been written about it in France or in other countries. He has three libraries: firstly his own; then that of his Faculty, which he can use from the catalogue; lastly the National Library which he frequents.

This fullness of learning rather paralyses his initiative; for in the immense and confused storehouse of scientific documents, there is scarcely a subject that has not been already broached. The original worker, if he is not learned, is liable to repeat experiments which have already been done; then afterwards he is obliged to state with regret that someone has been before him, and has observed many years ago the phenomena with the discovery of which

he was flattering himself. That is bad enough even when one has not yet published anything; but it is painful when one has published, as new, something which was already known, and when some not too well-disposed colleague unearths the account of it which has been overlooked. The well-informed worker does not expose himself to these rebuffs. On the other hand, he may know too much about what has been printed by others to be truly original himself. Perhaps it would be better never to publish an experiment except after profound study of the appropriate bibliography, and yet not to encumber oneself with too much knowledge before experimenting. . . . But I must stop, for general statements are of no use. It is a matter of proportion, of instinct; and we have no advice to give.

D. *Teaching.*

The professor loves to be surrounded by his pupils, to lead them along right lines of study; he talks to them, shares his ideas with them, gives them advice. He is happy when he can plan out a research. Voluntarily he passes hours with his pupils trying to inspire them to labours

which are very dear to him. He founds a school. Both technically and bibliographically he helps the students in his laboratory. To find them some slight document, he would not hesitate to search his library from top to bottom.

And then he loves teaching. He gives up a great deal of time to the preparation of his lectures. He assists beginners in practical work, and it is his delight to show novices in Chemistry how silver or chlorine are to be estimated, and what are the conditions for a good analysis.

Even those who are very learned are often not indifferent to the efforts of their pupils. Ludwig at Leipzig, Sainte-Claire-Deville, Würtz, at Paris, although creators and discoverers, had around them cherished disciples, who contributed in large measure to ennobling their name and enriching their work. When a master has succeeded in drawing around him a group of young men eager for science and research, there is soon established between them a charming fellowship. A laboratory is a place where all work together. A happy definition. To work together! That is delightful. One is young,

full of enthusiasm, with all the vigour of health and all the optimistic hopes that the cares of life have not yet been able to damp. And then, while working, one talks and criticizes, and is interested with more or less of scepticism in the efforts of one's comrades. There is good-natured joking about the whims of the master; some amorous adventure is discreetly whispered; some ancient out-of-date theory is demolished; some new theory, still imperfect, is ridiculed. But then again someone extols it: and passionate discussions arise. One dares not speak of fame . . . that is too distant a goddess. . . . but one hopes that the work undertaken will succeed. Ah! happy days! Afterwards, long afterwards, the savant, grown old, weighted with years and with titles, will recall gratefully those days of long ago; and he will try to group around him, in the immense laboratory that he now directs, pupils of whom he can make friends—studious, active, full of enthusiasm and ardour, who will remind him of a dear and distant past.

To sum up, it is necessary that the savant should be first and foremost an original dis-

coverer; then, if possible, a critic, a technician, a scholar, and a teacher. If he has all these virtues, then he is great among the great. But is it possible? Yes! Have we not had Claude Bernard and Pasteur.

If it were necessary to sum up their attitude in a word, I should say that they were as audacious in hypothesis as rigorous in experiment. That is all excellent, perfect, admirable. But happily they had something else, which gave impulse to their genius and made their work fruitful. They had enthusiasm. And I was wrong when I spoke just now of originality as the most essential quality. The chief and first virtue, without which nothing is done, is faith in one's science. For the savant, science must be a religion. Everything that is discovered, be it great or small, has its origin in this faith. To use an everyday expression, but one which nevertheless conveys my thought, he has to believe that *C'est arrivé*.

O raw young student! who art beginning the study of weights and measures, and, thou, old grey-haired professor, whose face is ravaged with wrinkles—though you work till your hands

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are nerveless and your eyes are dim, whether from duty or habit, for a hobby or a means of living—never will you achieve anything but poor work and trivial results, unless, hoping to make a name that shall long live in the memory of men, you enter your laboratory with the ardent faith of the neophyte who rushes to martyrdom to sacrifice his life for his God!

Chapter VII

A LITTLE FANTASY

AND now I must vigorously excuse myself. So far, in these few pages written to endear science and savants, I have been serious. But now I am going to cease from seriousness and paint some fanciful portraits of savants who have never existed. It is no use searching for a key to these characters, or for any reality in the phantasmagoria. These portraits have amused me: that is all: and I should like them to amuse my reader also, if I have a reader. But I am sure he will not be so diverted by reading them as I have been by writing them.

MÉLOTIME complains about everything: though really there is no justification for his grumbles, for he occupies an important position in the University. Mélotime has precious little merit, for not yet has he encountered a new idea, but he complains continually that he is unrecognized and persecuted, pursued by latent

or open hostility. He moans about everything. His study is dark and damp, and, moreover, looks out upon a courtyard always infested with emanations of sulphuretted hydrogen, as well as the stench of dog-kennels. Of course, all that is necessary is for the professors of chemistry and physiology to say a word to their pupils: but no, they just treat him like a pariah.

It was six months before he could get a water-pipe mended. He hasn't yet been given electricity;—it doesn't sound credible, in 1926. And it is always he who is burdened with examinations, reports, commissions, registers. All the most thankless tasks are given to him. He has only one assistant, and this one a commonplace student who has been almost forced on him. He is, of course, a knight of the Legion of Honour, but all his colleagues have a higher grade of the order. And what colleagues! Lamentable! He smiles bitterly. He worries successive administrators with unsatisfied demands—and when he does not get everything he asks for, says, "That's what comes of being independent." But his independence consists in making himself unbearable.

A LITTLE FANTASY

EUPHORMION is a savant: there is no doubt about that, for he is professor in a Faculty; but it is not science that dominates and directs his ideas. For first and foremost he is a reactionary, a reactionary in everything. He does not wish for progress; for what the public calls progress is to him only a form of decadence. He resents all new discoveries without knowing what they are, without even wishing to know what they are. Before it was proved that flying-machines could be constructed, he was most indignant that men of good sense could believe in the heavier-than-air notion; and even now he still piously takes note of all the aviation accidents, for it is impossible that this absurdity should ever be anything but a perpetual instrument of death. He will admit neither the stylograph, which spreads ink everywhere, nor typewriting, which takes all personality out of writing, nor automobiles, costly machines which assassinate pedestrians. Frozen meats are nauseating and unhealthy, and the various concentrated milks, which are sold in the dirtiest grocery-stores, are poison. Nothing can find grace before his universal neophobia. He would be lacking in respect to his

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hearers if he did not give his lectures in dress clothes. As for some general and generous ideas which certain thinkers have promulgated, they are pestilential. An auxiliary common language is the most infamous monstrosity, and the people who propose it ought to be put in prison. He cannot bear to hear the telephone mentioned. A tunnel under the Channel, what horror! Art is in still worse plight. There has been no good musician since Rossini. In poetry and drama, since the days of Racine and Molière there have been only botchers. The eccentricities of crazy novelists have introduced confusion into all literature.

SIMONIDE, in his youth, passed several years in distant countries, dangerous and inhospitable places, in order to study the marine fauna of those little known lands: and now he teaches Zoology in one of our great Universities. No one then can reproach him with being a coward, and yet he lives in perpetual fear. He is terrified of newspapers and of journalists. Every time he publishes new observations, he trembles at the idea of being harshly criticized. At the end of

an interview, conducted by some unknown unimportant journalist, Simonide was ill for several days; just because, in some rag of a paper that no one ever reads, this journalist had treated Simonide humorously. At his lectures he looks anxiously round the room to see whether one of these odious reporters is not hiding among his students. Fortunately, this terror does not paralyse his initiative; and he has enunciated daring ideas, for he is a pioneer. But rather a scared pioneer! He does not know, in spite of all his science, that the opinion of the crowd is like that of a strumpet kept by a gang of ignorant rascals.

EPISTÉMON teaches botany, and is devoted to teaching. He appreciates those pupils who attend his lectures regularly, and does not conceal his dislike of absentees. That is why he loves to sit as often as possible on examination boards in order to support the candidates who have been his pupils. On certain Sundays during the summer he conducts botanical excursions; and as he has an excellent memory, he recollects the faces of those who come. Unfortunate are

those who, for any reason whatever, fail to put in an appearance; for at the examination-table, when they are seated before him, he ploughs them mercilessly, by putting to them, with great gentleness, the most insidious questions. And if they reply badly, they have lost the day. The students are not much afraid of Epistémon; since they know that to be successful it suffices to have attended his lectures and his botanical walks. On the contrary, they are greatly afraid of MARCELLUS, who is very ugly, and has been seriously deceived by his lively wife; of which fact Marcellus is not ignorant. So when at examination time, students present themselves who are not too bad-looking, he takes a bitter joy in first of all saying disagreeable things to them, and afterwards ploughing them.

Early in the day, GILDAS enters his laboratory in silence, and does not stop in any of the large rooms on the way to his own particular study. To this small dark room he retires for the whole day. Once there, he does not wish to be disturbed, and his instructions are to say that he is out. He has, however, a reception day, the first

Thursday of each month except during holidays, between ten o'clock and midnight. He is not the least interested in the studies his pupils have undertaken; probably he hardly knows the names of his assistants. He does not communicate with them, and does not wish to admit any confidant to his research. At long intervals he publishes some memoir abounding in reticences; for at no price will he divulge his methods. He is haunted by the constant dread that someone may crib his ideas. He locks his note-book of experiments in a drawer with a treble lock, and takes great precautions that no one shall know exactly what he is doing. But in truth he need not be afraid; one would have to be utterly senseless to wish to crib from Gildas any of his ideas—for he has none.

What distinguishes MÉNIPPE is that he has no distinctive character. He is "everyman." He conducts careful researches, and, every three or four years, publishes a reputable memoir. He has written a "Treatise on Bio-Chemistry," which repeats, with a few not negligible additions, what has been said in preceding treatises. Ménippe is assiduous in his

laboratory, but his assiduity does not lead him to come before two o'clock nor to stay after six. With his pupils and his colleagues he is on the most suave terms; never does there escape from his lips a word that is picturesque, or discourteous, or deep, or amiable. His private life is calm, discreet, self-contained. It is known that he is married, and has a son and daughter: but that is all. His lectures are without errors, and without important omissions, but nothing is said in them which does not occur in classic works. One cannot say that Ménippe does not love science, for he reads nothing but papers on biological chemistry, and he is reasonably well up in all the branches of science he teaches. At meetings of the Faculty, he is listened to, for he is wise. One would never be compromised by following his opinion, for he is a moderate among the moderates. He has thus always unquestionably taken a place in the front rank.

ALCIDAS lives in the clouds. Yet he is not a Meteorologist, but a Physicist. Nevertheless, he sees nothing in Physics but mathematical laws. He has formulæ for all phenomena, for he

knows that God geometrizes. Colour, viscosity, elasticity, cohesion, density, electricity, affinity, momentum and rotation—all are properties and functions that can be expressed by integrals. In the street, Alcidas runs a risk of being run over twenty times a day; for, instead of looking at the automobiles that arrive like projectiles, he is thinking out some new and still more complicated equation. When he has got hold of a formula, he will not let it go until he has extracted from it all that it contains; and he forgets, while solving it, the sense of what it signifies and its adaptation to reality. Thus he is more platonic than Plato himself; for he lives and reasons as if there existed no concrete realities,—but only abstractions.

ARCHIBALD is a mineralogist, and he is interested in the appearances of polarized light seen through the most unusual crystals. He has found ingenious methods for getting fine crystals out of substances which hitherto have been rebellious. But he has another passion, a passion for games, whether it be bridge or poker. When some friend comes to his labora-

tory to get him to make up a party, he suddenly abandons all his goniometers. He has a double life. When he is playing bridge, he thinks about the sesquichloride of lanthanum and ytterbium that is going on crystallizing down there without him. And when his eye is glued to his microscope, he is dreaming of formidable no-trump hands. In his vast pocket, his book of calculations fraternizes with a pack of cards; and he gives his whole soul up to these two divinities, who live on good terms with one another.

AGATHON is a clever chemist, who yet is cautious enough not to exaggerate the merit of his own work. He is severe on himself, no doubt, but much more severe on others. His caustic humour is exercised mercilessly on all contemporary chemists: he applies all his diligence and knowledge to discovering the faults they have committed, which is not very difficult. Especially he delights in bringing to light obscure workers who by their *soi-disant* discoveries have forestalled the illustrious masters of to-day. He thus found that PHILIBERT, his rival, is not the originator of the famous theory

of the hexatomicity of chromium (1896), for it was already known in 1892; as can be proved by looking up page 322 of the Bulletin of the Academy of Cracow. As to MÉGAPHORE, who is honoured with great respect by an ignorant public, Agathon smiles bitterly when they praise him. For Mégaphore has discovered nothing. People sometimes speak of partial polymerism as attributable to him. All a mistake! Mégaphore is not in the running; and one of the great joys of Agathon is to cite a certain phrase, printed ten years ago by a young Bolivian engineer, a memorable phrase, which takes from Mégaphore all right to priority.

EUSTHÈNE would be irreproachable if he had sufficient strength of mind to resist feminine charm. Not that he is a debauchee! A widower, and father of two charming girls whom he adores, he leads a most steady life; but he attracts to his laboratory young girl students, and the prettier they are the more interested is he in their work. On the slightest pretext he brings them into his study, and listens with deep feeling to the account of their experiments.

The most naïve among his pupils cannot ignore this weakness of Eusthène; for in his professors' study, encumbered with phials and microscopes, though nothing improper takes place, two chairs are drawn close together, and occasionally hands touch. Eusthène, who is no longer young, knows himself that he is ridiculous. But he is incorrigible. It is in vain that one of his colleagues repeats to him the counsel of Don Quixote to Sancho Panza. "If a pretty woman demands justice of you, shut your eyes when you listen to her." Never at examinations does Eusthène shut his eyes, and his indulgence is limitless when the candidate is prettily agitated.

If ÉPHARISTE has not many ideas, he makes up for it by having one most tenacious one, to which he subordinates everything. It is that Germans are scarcely human. When their names are mentioned in connection with some scientific work, the credit is given them unfairly, for they stole their pretended discoveries from French savants. Over there, there are no savants, only pirates of science. When they write, it is either incomprehensible rubbish, or bare-faced plag-

iarism—one or the other. Gauss, Kronecker, Helmholtz, Hertz, Röntgen, have discovered nothing: for discovery is contrary to German genius. Moreover, the morality of students and professors beyond the Rhine is of a lower grade even than their intellectual capacity. He, therefore, who believes that such people can be capable of anything that is not despicable, is not only a fool, but a bad Frenchman into the bargain. Never in his lectures or his courses will Éphariste pronounce the name of a German savant. Yet he has learnt something of the uncouth language of those barbarians, in order to collect the absurdities that they pour forth on the other side of the great river; indeed, he has made a big and authentic collection of them, which is added to every day by further incredible monstrosities.

CALLIMÈNE is a professor of Histology, and he has made rather important discoveries in this domain. His lectures are followed; his laboratory is frequented; his books are read by a fairly large scientific public. But Callimène has no love for Histology. He has been seized with a

passion for Astronomy, albeit he understands nothing of mathematics. He is enamoured of anything that touches upon the story of the sky. He is an assiduous correspondent of Flammarion societies. He reads nothing in the *Comptes rendus de l'Academie des Sciences* that has not a bearing upon Astronomy; he wears himself out over figures and equations. Sun-spots, the canals of Mars, the tails of comets, the appearances of new stars, all these far-off phenomena, about which he has only the most primitive notions, invade his thoughts; and from them he comes to despise the morphology of the liver in molluscs, and the histology of red corpuscles—which it is his mission to teach.

PHÉRÉCYNTHE has no ambition. He boasts no title, belongs to no Academy. At an early age he gave up his business in furs, which did not appeal to him, in order to devote himself to the micro-chemistry of a certain red-colouring matter peculiar to some Mediterranean sponges. This curious substance has become the object of his profoundest attention. Although a friend has reserved for him a tiny room in one of our

largest laboratories, he mostly works at home. As he is a bachelor, he can, in his narrow quarters, give himself up entirely to his passion for the red of the Suberites. With a good microscope, some test-tubes, and an alcohol lamp, he can filter, precipitate, re-dissolve, so as to analyse the various shades assumed by the red of suberites under all possible variations of action and reaction. He has, moreover, an admirable scientific probity, and will not publish anything until he has verified it a hundred times. So now, here he is, coming to the end of his life, and he has published already four notes on suberites—one nearly every ten years. But he realizes that he is only at the beginning of his studies.

PHOCIDON has numerous pupils, which is scarcely surprising, for he sacrifices everything for them, even justice. Phocidon, when conducting an examination, always gives the maximum to his own pupil, whatever his answers may be, and disparages the efforts of a competitor with a readiness and a partiality which would be a scandal were it not, in certain quarters, almost

a habit. Hence it follows that Phocidon has not the soul of a savant; for the soul of a savant, even when swollen with pride, maintains always a certain respect for equity.

NICIAS has a deep and curious mind. He knows in detail all that has been written on the subjects he studies. An indefatigable worker, he will not let himself be beaten by any difficulty. His criticism is penetrating, and his perspicacity incomparable. He has the double gift, often contradictory, of bold generalization and scrupulous exactitude. Yet he has never done work of more than moderate character, the import of which is by no means revolutionary. By common consent, Nicias is one of the greatest and surest intelligences of this century. But fate has treated him badly, and he is superior to his work.

ARAMIS has the narrow mind of the small trader. He works but little, without zest; he only knows odd scraps of the science he is appointed to teach. He is, moreover, an obstinate man, hostile to modern ideas which he does not understand, and has no wish to understand.

Yet the other day he made a great discovery which has transformed an ancient time-honoured theory and regenerated science. Fate has served him well, and he is inferior to his work.

RAYMOND has a mixture of the fate of both Nicias and Aramis. He gave up thirty years of his life to studies which brought him nowhere. Yet all his energy, all his talent, all his hopes, were devoted to those studies. Between times, he diverted himself by another research, which cost him but a few weeks of labour, and which will render his name immortal.

MÉONIUS, in his youth, was a great worker and produced fine stuff. Each year was marked by some discovery. Thus legitimate honours fell upon him like a beneficent shower. But at the age of fifty, he took a sudden dislike to well-deserved rewards. Disgust for men led him to a disgust for science. He fled far from Academies, laboratories, disciples, to an obscure retreat, where, as he watches his flowers grow, he savours the pleasure of having nothing more to give to, nothing more to ask from, either things or human beings.

EURLAS made for a long time an interesting study of the sounds emitted by certain night moths. He noticed that this shrill noise is produced by the rubbing of a leg against a membrane stretched like a drum. His discovery is small, but real. It has, however, so pleased and absorbed him that he devotes to it all his energy and all his admiration. It has become the central pivot on which his existence turns. For forty years he has meditated on this phenomenon; he has enlarged it to the extent of making it one of the bases of Zoology and consequently of Nature herself. The sounds of moths create a link which unites vertebrates to invertebrates, and it is by this means that one of the great mysteries of the Universe will be solved. There is no problem that cannot, by some means, be linked up to this noise of moths. It is connected with physics, because it is a question of vibrations of sound. It is allied with sociology, because the reproduction of mischievous insects is connected with the soundness of their vocal organs. Indeed, Eurylas, who prides himself on being a psychologist, is not unaware that he has a

small bee in his bonnet; but he does not worry about that, and if you go to see him, he will say, "Everybody has his hobby; and I have mine: mine is excusable by reason of the importance of the subject." And he talks about it, he describes his discovery for the millionth time, he is mad about it, drunk with it; he has forgotten the psychology of hobbies.

Aristée sells coal; Phalandor, cloth; Mathias, lamps; POLYCTOR makes a business of science. It is a trade that he has taken up, a trade which, all things considered, is no more laborious than any other. A grocer is hard-working and always in his shop. In the same way, Polyctor is devoted to his laboratory. Each day he goes to his savant's duties, and studies conscientiously, by classic methods, one of the scientific problems of the day. In this way he has executed some creditable works, of which the number and the value suffice to afford him some notoriety and a position in which he can live sufficiently well in a small way. That is all Polyctor asks of science. By dint of economy, he has been able to provide a *dot* for his daughter, and acquire a small villa

on the outskirts of Paris. Whilst awaiting his retirement, he rests, and wants to hear no more about a trade which he has always found rather boring and useless.

The cynicism of Polycrator has always made me feel a great respect for the ingenuous enthusiasm of Eurylas.

EPHIDORE is a real savant, and, moreover, a first-rate man. He has made interesting discoveries which raise him almost to the front rank. Everything has smiled upon him, both events and mankind, and nothing seems to be lacking in his successful career. Yet Ephidore is not happy. A care preys upon his mind; it is because Ephidore is not given the position that he deserves. All the esteem in which he is held is indeed far below what he feels due to him; for his discoveries, even the least of them, are revolutionary and open up infinite possibilities. Nothing was understood before his time. Everything has been illuminated by him; and it is a woeful injustice that he is not put well in front of the first rank. Sadder still, as he confesses in his moments of frankness, is the fact

A LITTLE FANTASY

that he himself is not able to appreciate the whole breadth of his work; he declares himself powerless to estimate the complete extent of his own genius.

Chapter VIII

SOME REAL SAVANTS

IF I have painted fancy portraits it is not because, in my long life, I have not known many real savants, great savants, such as Marey, Berthelot, Claude Bernard; though with those, alas! I was never intimate. For various reasons: perhaps because I was independent in character and in circumstances, for I was never really the pupil, that is to say, the intimate disciple, of anybody. I worked in the laboratories of Würtz, of Berthelot, of Marey, of Vulpian; but that was at the beginning of my career, and it is my great regret that I was never their collaborator. They scarcely introduced me to their researches, and of my own obscure and youthful work they knew practically nothing.

MAREY was the one that I saw most of. He was a man above his fellows. While he was living no one rightly appreciated his magnificent intellectual superiority; his glory increases as

time goes on. He has to his credit three simple things, the kinematograph, aviation, the recording drum. That is all. One would think it sufficient!

True, he was not entirely responsible for these great inventions. Janssen had photographed the phases of the passage of Venus over the Sun: Muybridge had photographed the movements of the horse; but it was Marey who brought to perfection these rather baffling ideas. By means of his "photographic gun," he managed to note the phases of movement in a pigeon's wing, the running of a man, the bursting of a soap-bubble, the attitudes of a cat falling from a height. One knows now what, thanks to Lumière, kinematography has become. But I am talking now of the year 1883. Forty years ago, nobody could have foreseen that throughout the world, in 1923, there would have been thousands more cinemas than ordinary theatres.

Certainly Marey did not discover aviation. He never constructed a flying-machine. Cayley, Renard, Lilienthal, and especially the brothers Wright, were responsible for that. But Marey

it was who inspired and directed V. Tatin. He said to me once, "Associate yourself with Tatin; work with him, for he is on the right track." And, in fact, Marey alone, alone, absolutely alone among physiologists, physicists, mathematicians, alone among the savants of all countries, was convinced of the truth of what then seemed to us absurdly naïve—namely that the bird flies only by simple and natural processes, and that consequently, the conditions of this flight being mechanical, one could achieve flight by mechanical appliances. Indeed, with Tatin, we first experimented in the courtyard of the Collège de France with a machine having flapping wings. The results were execrable. We had to give it up, and resort to the aeroplane. Then from 1892 to 1895 we constructed several aeroplanes (not piloted) absolutely identical with actual aeroplanes, but propelled by steam instead of by the detonation of gases. The principle of the machine was absolutely the same as in the machines of to-day.* Marey

* We were preparing a large flying-machine capable of carrying a pilot, when the great discovery of the Wrights was announced.

died before he saw the realization of his dream.

But, whatever interest he attached to the kinematograph and aviation, the thought that dominated the whole life of Marey was the graphic or recording method in Physiology. He applied it in every direction, without intermission, discovering unexpected uses. He was initiated in the study, or at least encouraged, by Donders, the great Dutch physiologist, whom he held always in affectionate remembrance. From the moment he knew Donders, the graphic method became henceforth part of the intellectual individuality of Marey. He made a fetish of it. "When a graph is bad," he used to say, "it is because the experiment is inconclusive." No one knew better than himself how to take an elegant and demonstrative graph. He could thus explore secret subtleties.

Also, he loved to work alone. So as not to be distracted by some clumsy collaborator, he used to shut himself up in his study, "to play about" (*bibeloter*) as he used to say. He had begun his career in a private apartment: and in the same

isolation he continued. He fled from the great rooms of the Collège de France, where one is troubled by passing visitors, by importunate people, who know nothing about experimentation. He hardly bothered at all about his library, and did not care to waste his time rummaging in other works, for, after all, if they did not treat of graphic records, he despised them.

Moreover, he had the greatest perspicacity in judging physiological phenomena; and although he was not widely learned in physiology, he had penetrated it deeply.

He was not in the least ambitious, and, indeed, rather scorned academic procedure. When he was a candidate for the Académie des Sciences, one of the academicians said to him: "You have presented yourself against Paul Bert . . . that is enough for me, I will vote for you." And although he obtained this vote, Marey was indignant at it.

He hated teaching, lectures, discourses, conferences. Still more he hated commonplace phrases and idle conversations. He never spoke out emphatically. His irony was gentle, good-natured, rather sceptical. He hid the goodness

of his generous soul under a cloak of indifference.

He used to speak with emotion of the great friends of his youth, Lorain, Brouardel, Aphonse Milne Edwards.

Loving good literature and art, as well as the beauties of nature, he was attached to Italy and the sky of Naples; and his villa of Pausilippe was dear to him.

The dominating trait of this great savant was simplicity. No ostentation; no pride; no vanity; no feelings of envy and hatred. He was like a great beautiful river, deep, very deep, which peacefully follows its course, and leaves fertility wherever it passes.

MARCELIN BERTHELOT was a man of prodigious genius. And yet, powerful and strong as was his work, to me the man himself seems superior even to his work. Pasteur, who leaves behind him a work even greater than that of Berthelot—since it is, without contradiction, the greatest of all human works—cannot be regarded as superior in intelligence to Berthelot and Claude Bernard.

I scarcely knew Berthelot until he was already at the height of his glory, full of honours, and burdened with much business. Senator and perpetual secretary of the Académie des Sciences, member of the Académie Française, President of the highest Council of Public Instruction, he had but little time to devote to his laboratory. He used to call in when passing, always finding some ingenious modification to point out to his pupils, or to his assistants, whom he used to stimulate to work vigorously, unsparingly. I was at one time rather astonished at this, but now I think he was right.

The outlines of all sciences were familiar to him; and in talking with him one was impressed by his broad ideas, his deep insight, enriched by marvellous knowledge and unfailing memory. Never was one bored. I had the honour of going to his house often for the Sunday soirées. It was delightful to hear him talk. Madame Berthelot used to listen to him with admiration and adoration. It is well known to what extent these two fine destinies were united in life as in death. Madame Berthelot died after a short illness. When M. Berthelot, himself ill, heard

of her death, he said nothing, but asked to be left alone. He stretched himself on a couch, and when he was found, two hours afterwards, he was dead.*

I am not speaking of Berthelot as a professor. Even more than Marey, he detested teaching. On the contrary, Würtz, his rival, loved teaching: he was an admirable professor. Really, one cannot imagine any more striking contrast than between these two great chemists. Würtz used to arrive in his laboratory, boisterous, jovial, chatting to this one and that, inspiring no more fear than a good comrade; whilst Berthelot, cold, severe, lost in thought, used to be approached timorously.

Neither of them was content with making the discoveries which immortalized his name; they each wished to be something in the State.

* Madame Berthelot, who was very beautiful, was a woman of noble intelligence, of exquisite grace, and of high virtue. A poor devil of a scribbler, who didn't know how to write verses, starving, pitiable, ugly, proudly wearing his dirty old hat and his down-at-heels boots, used often to come begging from me. One day he said to me: "I am tired of living alone. Find me a wife." And when I hesitated, he added: "Somebody of the type of Madame Berthelot."!!

Würtz became Dean of the Faculty of Medicine, a thankless and unpleasing task.* Berthelot became Minister of Public Instruction, and even Minister for Foreign Affairs.

* * * * *

Since I am talking of savants who, in the far-off time of my youth, welcomed me in their laboratory, I must not forget Vulpian; though, indeed, I hardly knew him. If Berthelot's manner was cold, that of Vulpian was colder still. He was, like Berthelot, perpetual secretary of the Académie des Sciences, and, like Würtz, Dean of the Faculty of Medicine. May I be permitted to express the opinion that these remarkable men might have employed their time better than in these tasks—which need a strong dose of self-renunciation?

When I knew Vulpian, he was too busy to devote much time to laboratory work. On rare

* Brouardel, who was for a long time dean, and an excellent dean, used to say that a dean is always struggling—against students, the government, and his colleagues. “With the students,” he told me, “I can usually arrange things. With the government, it is often very difficult; but still, one manages; . . . whilst as for one's colleagues,—!!”

occasions I saw him experimenting. He was meticulously careful and precise, rather like a short-sighted person, as he used to say; his critical acumen was very developed, and indeed so piercing that originality was paralysed by it. His lectures were very learned, full of knowledge and of judicious criticism. They were worthy of publication, and were published.

In short, Vulpian, who had a very great mind, was superior to the work he left behind; for he made only small discoveries of detail. He deserved better things; for no physiologist can be compared with him for sureness of judgment and learning. We may well ask ourselves whether there is not some incompatibility between the spirit of criticism and the spirit of discovery.

How many other names could I cite! What facts! What anecdotes about this one and that! These stories would nearly always show that the soul of a savant is naïve, generous, enthusiastic; so that it is easy to pardon their little failings, which detract neither from their genius nor from their humanity.

When I was Director of *La Revue Scientifique*, I resolved, with my excellent friends, Gaston Tissandier, Director of *la Nature*, and Max de Nansouty, Director of *Génte Civil*, to found a kind of periodical reunion which we called *Scientia*. They were fairly modest banquets offered every two months to some eminent savant.

The first savant to whom this honour was paid was the doyen of that period, Chevreul (he was at that time 102 years old). I went to invite him. He was very amiable; but talked strangely, as was to be expected at his age. . . . "I accept your invitation to dinner," he told me, "on two conditions." I bowed. "First, there shall be no fish."

"No, Monsieur Chevreul," I responded with vivacity, "I swear that there shall be no fish."

"As to the second condition," he went on, "it is that there shall be no politics."

"Not a bit more politics than fish," I replied. Then he accepted. At this banquet, M. Chevreul, at dessert, rose and made a speech to which there was no end. He talked and talked; perhaps he might still have been talking had

not M. Frémy, who was presiding, interrupted him by rising and saying in a loud voice: "To the greatest chemist of the world. Homage to M. Chevreul."*

Another *Scientia* dinner was offered to M. Pasteur; another, to M. Berthelot. On this occasion, Renan presided, as an intimate friend of Berthelot, and made a delightful speech. "Young men, young men!" said he, as he finished, "devote yourselves to science. Therein lies everything of importance."

Yet another dinner was given to M. H. de Lacaze-Duthiers. I had been his pupil, and was his admirer. Certainly he was not faultless, but he made up for the asperity of his character and the violence of his hatreds by his love of work and fidelity to his friends—traits which were as strong as his antipathies. His discourses were picturesque, full of imagery: he entertained his hearers with his efforts to endow the laboratories of Roscoff and Banyuls. "This year," he told

* This first *Scientia* banquet necessitated several visits. M. Chevreul put to me point-blank this embarrassing question. "Do you know what a fact is . . .?" I was taken aback. "Is a sheep a fact?" And I don't remember my reply.

us, "I have travelled nearly six thousand kilometres between Roscoff and Banyuls and Paris, without counting my visits to the ministry." Of each of his colleagues at the Académie and at the Sorbonne, he kept a secret dossier, which he took pleasure in adding to, from things people told him. His conversation, sown with piquancies, was very attractive, but full of unexpressed hints. "X. . . . ah! ah! X. . . . do you know?" And I would pretend I did. "Y. . . . ah! ah! Y.? He is like B. . . . you know all about it, B. . . . who" Yes, indeed, one had to be cautious in speaking to him, for as soon as the visit was ended he would write down carefully, before the memory of it had faded, every phrase one had used. At examinations he was rather queer. The École Normale was his *bête noire*, he considered the examiners there harsh, if not often unjust.

Between H. de Lacaze-Duthiers and H. Baillon, Professor of Botany at the Faculty of Medicine, the resemblance was striking. Baillon was an admirable professor, amusing in conversation, biting, keen, very fixed in his hatred of the botanists of la Sorbonne, of the Muséum, or

of the Institute. But assuredly he was the man who knew better than anyone in France—perhaps in the whole world—the names and characteristics of plants.

In the early days of his professorship, he pitilessly rejected students who were not instructed in botany; and, since they readily failed over some treacherous word, they were rejected wholesale: which led to indescribable shindies. So poor Baillon was reduced to accepting every candidate. It sufficed even if one made no reply at all. He would ask: "What is a carpel?" No reply. He would look disdainful, and continue: "What are the characteristics of Ranunculaceæ?" Still no reply from the student; for his opinion on Ranunculaceæ would be much the same as his opinion on carpels. Baillon's disdainful look would grow more pronounced. . . . A prolonged silence; and the student is accepted.

I scarcely knew—to my great regret—the three greatest savants of the past century, and perhaps of all past centuries; Henri Poincaré, Pasteur, Claude Bernard; three powerful and marvellous geniuses, flowers of our France.

I saw Henri Poincaré once, during a visit of candidature; he listened to me absent-mindedly (and was perfectly right in so doing), but, as one can readily imagine, my visit lasted no longer than two minutes, and he scarcely vouchsafed me a reply.

I cannot say anything personal about Pasteur, with whom I rarely conversed. On three different occasions he wrote me delightful letters, which I keep piously. And certainly it is admirable and surprising that, amongst all his work and labours, he should have found time to write to me.*

As to Claude Bernard, whom my father knew well, and to whom he presented me one evening at the house of his friend Mme. Raffalovitch, I had scarcely begun the study of physiology when he died. I had, however, followed with great admiration his lectures at the Muséum. But it was not his lectures which influenced me directly.

* Formerly, when I was made doctor of medicine, I sent a copy of my thesis to all the professors of the Faculty without exception. Only two of them replied: Vulpian and Charcot. They were undoubtedly the most illustrious, perhaps the only illustrious, members of the Faculty. So I am convinced that politeness is not incompatible with fame.

One day, in the courtyard of the Collège de France, as I was going to Berthelot's laboratory, I saluted him respectfully; he stopped and said to me: "You are studying gastric juice. Well, study that of fishes, it is of exceptional activity." That same evening I left for Havre in order to study the gastric juice of sharks.

If I report this anecdote, so insignificant in itself, it is in order to show what profit one may draw from a few words, even though apparently trivial, from a great man.

For Claude Bernard was really great among the greatest. In physiology he is the incontestable master, both for method and for achievement. And I claim to be his pupil, though unfortunately I did not work at his side; but I have so often read and re-read his inimitable books that his ideas have penetrated and inspired me continually.

I have been in fairly close touch with two other physiologists, genuinely illustrious men, Chauveau and Brown-Séquard. What a strange contrast between these two men, who resembled each other only in their extreme ardour for work and their passion for our splendid science.

Chauveau was solemn and slow; an excellent man, frankly and justly proud of his work. He could not say of himself, as did a certain celebrated savant: "I possess every good quality, but the one that distinguishes me above all is modesty." Assuredly Chauveau was not modest; but he leaves behind him such good work that an absence of modesty is legitimate.

As to Brown-Séguard, petulant, active, fidgety, meditating ceaselessly some new experiment, believing only in experiment, he was for young people an example of activity which age could not enfeeble.

I would willingly consider my friend Lippmann as the perfect type of savant. He had an admirable serenity that nothing could disturb, and a scrupulous conscience. At the same time both laborious and dreamy, he pursued in solitude his noble thoughts. Timid he was, moreover, fleeing from honours and the commonplaces of daily life; a delicate artist, delighting in the beautiful creations of the mind. Though kindly, he yet listened with an inattentive ear; for he followed his own thought rather than that of his interlocutor—which after all is quite pardonable.

One must rank, also, Ph. Sappey, professor of anatomy, among the finer types of savant. His cold monastic face, his severe bearing, his breadth of gesture, the solemnity which was natural rather than acquired, were all in keeping with an austere life entirely consecrated to work. He had attached himself to a rather ungrateful science, anatomy, in which there are few discoveries to be made. Nevertheless, he loved it passionately. When I was made Associate in both anatomy and physiology—for at that time the two sciences were covered by one course—I had made but a poor show in anatomy, so M. Sappey said to me: “Now that you are made a Fellow, promise me that you will learn anatomy.” And in all good faith I promised. But I would not swear that I have kept my promise.

The successor of Sappey was as whimsical as Sappey was precise, as impetuous as Sappey was calm: I refer to my friend Farabeuf. He was not really a savant, for there is scarcely any new work to be undertaken in the matter of human anatomy; but as a professor he was marvellous, incomparable, unique. Armed with pieces of differently-coloured chalk, while describing ana-

tomical contours, he would draw structures which took life under his hand. He used picturesque expressions, too, which students could forget no more than they could his drawings. All the pupils he had during a quarter of a century have kept a living memory of him. Farabeuf was a great, a marvellous artist. Alas! he had also the tormented soul of the artist, living in a strange and half unreal anguish, eccentric in conversation and manner, and afflicted with a queer mental instability that made him very unhappy.

Eccentricity, caprice, fantasy driven to extreme limits, are sometimes seen in savants.

My friend Munier Chalmas, who was an astonishing palæontologist, disconcerted our master Hébert by his habit of fantastic independence. There was a question of his being made professor at the Sorbonne; his nomination was certain. But to be a professor at the Sorbonne, it is necessary to be a licentiate and a doctor. How could Munier Chalmas be persuaded to pass, for the sake of form, these two examinations? He vigorously refused. Faithful friends, however, came to his house, made him

get up, dressed him by force in order to take him to Caen, almost *manu militari*, to the examination. A rather singular spectacle that. It appears that later, when Munier Chalmas was at the Institute, he became conventional almost to exaggeration. But it was not for long, for he did not live long after attaining his supreme position—too weighty perhaps for this admirable savant and at the same time incorrigible Bohemian.

The illustrious professor César Lombroso, of Turin, father of a model family, was not in the least a Bohemian; but he had an extraordinary originality. He was entirely devoid of critical faculty. If he found in a paper or in a book something which confirmed one of his theories—and the theories of Lombroso were as numerous as they were unexpected—he would embrace it immediately, without proving its authenticity. His fertility of imagination was inexhaustible; his power of work prodigious. He wrote a book on graphology, and his handwriting was indecipherable. He wrote a book on men of genius, claiming that genius is closely allied to madness, and he seemed by his own

exuberant and fantastic genius to confirm his theory. He wrote a book on the obsession of persecution, and he believed himself to be ceaselessly persecuted; for the most inoffensive criticisms terrified him. With a mind deep and rather unstable, he will leave behind him the name of a fruitful innovator. "He is a ferment," his friend and fellow-countryman, the witty A. Mosso, said to me one day.

These eccentricities are rare. In general, savants are most sedate; I have known some, and very great ones, who, in spite of the powerful originality of their minds, the fruitfulness of their inventive genius, had in them nothing of the Bohemian, and retained a mastery of their vast and ponderous intelligence:—William James, Sir William Crookes, Sir Oliver Lodge, Svante Arrhenius, and Frederic Myers.

Of these I saw most of Frederic Myers. Either at Paris, or at Cambridge, or in various travels, we passed long hours together in discussing that terrible science that I have called "La Metapsychique," a science immersed in dreamland. We tried to reduce it to order and to bring it up to the standard

of the older sciences, which are more positive because more ancient and more approachable. What I admired most in Myers was his scrupulous scientific probity. Although he had an excellent memory, he would take exact notes of all the circumstances of any experiment. His courtesy, his charm, his learning, were set off by a delicate sense of humour, which made his conversation delightful. He was a man of the world, in his manners far removed from those savants who wrap themselves in their speciality like bears in their fur; but he was a true savant in the most exact meaning of the term.

I have spoken, so far, chiefly of my masters, of those whom I have admired and loved. Perhaps I ought to speak now of contemporary savants, my colleagues, my friends, my pupils, and tell of my admiration for their ingenuity, their loyalty, their labours; but I should be afraid of offending their sense of modesty by saying what I think of them.

In representing the life of the savant, which is one long sacrifice to the needs of humanity, I am only afraid that I may appear, by my

fantastic portraits, to have shown them some disrespect. But no! A thousand times no! I must make myself clearly understood. The savant, despite my innocent criticisms, is for me, amidst all humanity, the ideal and most elevated type; and I would that all who read me might be as convinced on this point as I am myself.

Chapter IX

THROUGH THE AGES

WE are almost as powerless to picture the past as the future. The present tends to shroud everything that does not belong to it. So it is very difficult to form a just idea of the feelings which, in earlier times, inspired savants, and determined their attitudes, their habits, their methods, or the esteem in which they were held. Especially is this so since savants, then as now, are reluctant to recount in detail their little personal stories—for which one cannot blame them.

In ancient half-fabulous days, savants were in turn wizards, soothsayers, preachers, poets. PYTHAGORAS was of that kind. They were enveloped in clouds and wrapped in mystery, like the magi of Egypt and Chaldea. They mingled strangely the cult of gods with the observation of stars and the treatment of disease; and they worked more under the auspices of religion than of science.

So it was that about the fifth century B.C.—whilst Egypt, Palestine, Chaldea, Syria, and India were lost in futile though sublime theogony—Greece, our common mother, Greece, creator of the arts, made herself also the initiator of science, with Thales, Euclid, Archimedes, Anaxagoras, Hipparchus, Hippocrates. Of the life of these great men we know but little; even of their works we possess only fragments. We know, however, that they created science. Some hundred years after them, appeared Aristotle—Aristotle who summarized magnificently all the knowledge of his time: Aristotle who, without having made (except perhaps in Zoology) any scientific discoveries, is the most prodigious of the encyclopædists of all time. Comprehensive-ness was a possibility then; for in those far-off days science was not yet so vast that it could not be taught, understood, and written about by a single man. So this extraordinary Aristotle was able to compose learned treatises on all things, known and unknown.

In ancient times, in the domain of science, there were only the Greeks. The Carthaginians, Jews, Parthians, even the Romans, did not count.

Later, it was still Greek science which triumphed at Rome and Alexandria. The savants of that time were also encyclopædists, grammarians, rhetoricians, doctors, philosophers, sophists; often parasites. They conducted a school, opened establishments in the street, and charged heavily for their lessons; though, after all, their teaching was not worth much, being only wordy commentaries and doubtful flowers of rhetoric. No discovery is due to them. The days of science, in spite of Elien, Pliny, and Galen, were not yet come.

And soon the thick night of the Middle Ages covered everything with its devastating shadow. Poor science took refuge with the Arabs.

With the Italian Renaissance reappeared at last the dignity and the cult of Science. And immediately a deep differentiation was established between two groups of savants. This difference still persists to-day—a fact curious to note—though it did not appear markedly until the fifteenth and sixteenth centuries. A comparison between the Ancients and Moderns lends intense interest to the lives of the great savants of the Renaissance.

The one kind, who are much the more numerous, teach in the Universities. They have robes, titles, degrees, diplomas. They gravely instruct their pupils in all opinions of high respectability. Their orthodoxy is indisputable. They repeat the formulæ which have been bequeathed them by their masters; they mix together Saint Thomas of Aquinas and Aristotle, discover nothing new, but repeat what has been discovered, and fulminate against the pestilential innovations of fanatics. Thus, like the immortal Diafoirus, each of them is fixed in his principles like a Turk. They rummage in libraries, like the rats of which La Fontaine says (in very bad verse):

qui, les livres rongeants,
Se font savants jusques aux dents.

Whether they were doctors, jurists, physicists, astrologers, theologians, or grammarians, they all led a peaceful and useless existence.

Others, on the contrary, are adventurous, of not very reputable habits nor very accommodating character. Great travellers, they journey from one University to the other, Italy, France, Germany, Bohemia, unstable in their

researches, curious about anything that is new; for they find but little satisfaction in antique things. They expose themselves, by their exuberance, to the mockery of the crowd, the censure of the Church, the remonstrances of colleagues, the calumnies of public opinion. They have no great respect for either Saint Thomas or Aristotle. Their eyes are turned, not towards the past, but towards the future. These are the people who have resuscitated science.

But what misfortunes, what misery, what mortifications fell to their lot.

Galileo, exiled from Pisa, went to Padua, then had to take refuge in Florence, at the same time both honoured and persecuted. Put into prison, he was compelled to renounce his errors: his sublime errors! Descartes, also exiled, died in Sweden, after having lived a perilous existence, as soldier, as natural philosopher, as doctor. Vesale went from Brussels to Paris, then to Bologna, then to Pisa, and was constrained, in penitence for an imaginary crime, to make a pilgrimage to the Holy Land, where, shipwrecked, he expired of hunger. Bernard of Palissy, one of the most ingenious inventors of

all time, one of the founders of geology, a bewitching artist, died in the Bastille where he was imprisoned. Michel Servet, a Spanish savant, roamed about to Toulouse, to Lyons, to Paris, then to Vienne (Dauphiné), and, persecuted everywhere, took refuge at Geneva, where he met Calvin, who had him burned. The great philosopher Bacon was condemned to prison and made to pay a formidable fine: it is a miracle how he managed to escape his slanderers. W. Harvey, after studying in Italy and France, returned to London, and his house was pillaged by the populace. Ambroise Paré only escaped death through the personal protection of Charles IX. Athanase Kircher, a great savant, is driven from Germany, takes refuge at Avignon, goes thence to Rome, only to meet fresh persecution. Copernicus dare not publish his admirable work until the end of his life, and does not see his printed book till the day of his death. Kepler, although pensioned by the Emperor Rudolph, never receives his pension, and dies in poverty. André Césalpin, although doctor to the Pope, is accused of atheism, of pantheism, of sorcery, and is denounced by the Inquisition.

And yet surely Galileo, Descartes, Vesale, B. de Palissy, Servet, Harvey, Bacon, Ambroise Paré, A. Kircher, Kepler, Copernicus, Césalpin, are among the greatest names of science in these two centuries.

Yes. At the beginning of all sciences, one finds persecution.

Happily, in our days, savants are no longer exposed to these tribulations, these exiles, imprisonments, burnings. Since the middle of the seventeenth century, they have had some little authority in the world. All the same it must be understood that there still exist, to-day, two distinct groups of savants; the militant group and the satisfied group. Perhaps progress comes rather through the militants than through the placid and contented.

In the time of Louis XIV, science began to be honoured. It was accorded some prestige at the feet of the *Roi-Soleil*. But as yet it was nothing more than the humble servant of literature. The art of fine language still surpassed everything else. Nobody would have dared to maintain that Boileau was not superior to Cassini, to Leibniz, and to Huyghens. Pascal became more

celebrated through his "Provinciales" than through his "Traité du Vide."

But customs change rapidly.

Towards the middle of the eighteenth century, thanks especially to Voltaire, respect and almost admiration were accorded to men of science.

And savants themselves were transformed. The savant of the eighteenth century is not confined to his cell, nor does he perambulate the Universities. He no longer speaks Latin: he has become a man of the world: he writes to the papers. People listen to him voluntarily in the *salons*, where he loves to show himself and be sought after. Philosophically-minded great ladies, friends of Voltaire, of D'Alembert, of Diderot, of Fontenelle, were proud to think that they understood something of science. Their pretensions were perhaps more justified than they could be nowadays. Astronomy especially, since Kepler, Copernicus, and Newton—astronomy, whose horizons are so wide and of which the rudiments are so easy to understand—attracted these fair *savantes* who were wont to comment with enthusiasm on the *Entretiens sur la Pluralité des mondes*.

Physics and chemistry were as yet in a stage too rudimentary to attract. Mathematics, though it was progressing rapidly, was and is too dull and too difficult to be popular; yet unlearned people regard it from far-off with great respect, without daring to enter the temple. Medicine, with its dissection of men and its vivisection of animals, attracted but few. People were curious about it, but the discoveries were not sufficiently striking or sufficiently definite to inspire great enthusiasm.

All the same, in those days of philosophy, it was already understood that science must become mistress of the world. It was Voltaire especially, king Voltaire, who gave it the impetus. Voltaire, without being too deeply learned in any one science, touched upon them all, and, thanks to his supple intellect, understood a great deal. Assuredly, despite his sagacity, he committed several grave errors; he made game of the eels of Needham (because Needham was a Jesuit); never took seriously palæontological discoveries; smiled at marine shells found on the summits of mountains; and would not admit the brilliant conceptions of Descartes on

the mechanism of the universe. Voltaire was far from being infallible; but he introduced into the cultivated and civilized world of that time this main idea (which even to-day is not sufficiently dominant), that the future of humanity depends on savants; that the experiments of natural philosophers and naturalists, the observations of astronomers, the calculations of mathematicians, have as serious an importance as the most delicate literary diversions. Although he had a passion for poetry, he put Newton above all: and this lofty conception of the rôle of science is one of Voltaire's highest titles to fame.

Voltaire was not by any means the only prominent cultivator of science. Rousseau was a botanist. Buffon, whose high genius is much misconceived, was one of the principal personages of the time. Diderot, in "l'Encyclopédie" gave to science a place of honour. Euler was called to the court of Catherine. Helvetius formed part of Frederick's court. Science was no longer the Cinderella of earlier days.

Nevertheless laboratories scarcely existed as yet. The chemical researches of Rouelle in the *Jardin du Roi*, the admirable physiological work

of Haller at Basle, constitute almost the only exceptions. In Germany, Stahl made advances in Chemistry, though it was rather an absurd Chemistry; and yet in spite of its notable errors, it had a singular vogue. It was a good thing for chemical facts to be marvelled at, even though the current theories were absurd.

But then in the last quarter of the eighteenth century appeared three men of genius. Scheele, a Swedish apothecary, a chemist of incomparable genius; Priestley, who discovered a large number of gases; Lavoisier above all, Lavoisier who was the great master, the master of them all.

Lavoisier, the creator of Chemistry, creator of Physiology, one of the great names in all science!

He was rich, so that he was able to experiment without financial help. Thanks to a marvellous perseverance, an astonishing perspicacity, an incomparable logic, he managed to discover a whole series of absolutely new facts and establish an immortal theory. His experimental precision was as effective as his theorizing was audacious.

And Lavoisier is quite a modern savant. His style is picturesque, clear; it is a style suited to

the present day. He shut himself up in his laboratory, and constructed his own balances, his thermometers, his calorimeters. He wrote nothing about the experimental method, but all his work is an apotheosis of the experimental method.

Living examples have the greatest power. To read and meditate on the work of Lavoisier is to understand what a savant ought to be.

In a single century, from Thomas Diafoirus to Lavoisier, an immense stride was taken. Diafoirus was a savant of the Middle Ages, Lavoisier is a savant of modern times.

Chapter X

ON THE GENESIS OF EXPERIMENTS

ONCE again I am going to ask pardon of my reader, since I am going to talk about myself. But it will be in all modesty. Indeed, I want to show how, in any discovery, whether slight or important, our personal rôle counts for very little, so little that it amounts to nothing. It will be a rather humiliating profession of faith, since I attribute a considerable rôle to chance. Nevertheless, it will be recognized that chance was aided by perseverance.

I think that this naïve confession will be useful to young people, for we shall witness the genesis of a piece of work, and realize the phases through which the experimenter, guided by the facts themselves rather than by his own ideas, at last succeeds in establishing some new phenomenon which had previously passed unnoticed.

(1) My researches on gastric juice may be

said to have been due to chance, but to chance fertilized by three masters.

My loved master Verneuil, whose pupil I was at that time, had performed a gastrotomy operation on a boy whose œsophagus had been obliterated by the accidental swallowing of caustic potash in solution. This bold operation, then quite new, had succeeded, so that this young Marcelin had a fistula let into his stomach, through which the gastric juice drained and by which one could introduce food; for his œsophagus was completely gone. Verneuil said to me: "Repeat on Marcelin the admirable observations of Beaumont on his Canadian, and you will be sure to find interesting things." So, in Berthelot's laboratory, I began to study the gastric juice of Marcelin. I even noted, in passing, a fact which unfortunately I scarcely spoke of and on which I did not insist as I ought, a fact which was so well brought to light by Pawlow, namely that mastication and swallowing of food provoke by psychical reflex the efflux of gastric juice. It was truly remiss of me not to study this phenomenon more closely; I ought then and there to have demonstrated

this gastro-psychic secretion, which Pawlow, twenty years later, analysed with so much penetration. I tested the acidity of the gastric juice, before, during, and after digestion, when one day Berthelot said to me: "Try what you can get by the method of fractional separation [proportional solubility of the acids in water and in ether], you would be able thus to settle the controversial question of the acidity of the gastric juice,"—which was done, not without notable difficulties over which I must not delay. I have already recounted how Claude Bernard, meeting me in the court of the Collège de France, said to me: "Study the gastric juice of fishes, it is of extraordinary activity."

Did I not do well to follow the advice of my illustrious chiefs, Verneuil, Claude Bernard, Berthelot? We can never have sufficient gratitude for the suggestions given us by eminent masters.

(2) It was chance also that led me to ascertain the nature of *la polypnée thermique* [panting from heat]. No theory urged me to it. I set out with an idea which appeared to have no bearing on the question. But—and I

think that this is commendable—when facts present themselves to me, I am not obstinate in my opinions; I adapt my ideas to the facts which I observe.

There is a classic line which I wish to reverse:

Et mihi res non me rebus subjungere conor.

This precept seems to me to advocate a tactical error (at least as regards scientific procedure). I try to submit myself to facts, without any foolish attempt to make them submit to me.

I will describe by what unexpected detours I came to understand how dogs cool themselves by breathing rapidly. It is now a phenomenon so simple, so classic, so evident, that it is difficult to believe that it had not been always known. But no! certainly not! Before my memoir of 1885, the word “polypnée”—which I invented—did not exist, and no physiologist had understood the cause and the mechanism of this thermic polypnœa, which was confused with dyspnœa [difficult or obstructed breathing], and nobody understood its significance.

It was by successive stages that I arrived at this notion, and very indirectly. I knew, as do

all physiologists, that muscular contraction is due to the combustion of sugar in the blood; so I asked myself whether, by choosing animals in a state of fasting, and tetanizing all their muscles, I could cause their temperature to rise as rapidly as with normal, well-nourished dogs. I found that dogs electrified and tetanized get just as heated when they are in a state of fasting as when their digestive processes are fully active. My hypothesis, therefore, was not justified. Nevertheless, I thought I remarked certain differences in the heating of the dogs in which I provoked electric tetanus. It seemed to me that muzzled dogs got overheated more quickly than others, and soon became fatally overheated; whilst unmuzzled dogs, who were able to pant, got very little heated or not heated at all. A series of experiments, easy enough to devise, permitted me to prove that frequent respiration cools the blood by exhalation of water. Thus the cause and the mechanism of thermic polynæa were established.

Very rarely does one succeed in verifying hypotheses formed before beginning a series of experiments. Claude Bernard relates that

he had supposed, since the sympathetic nerve governs the functions of nutrition, that in exciting this nerve electrically one would develop heat. But experiment gave him a result absolutely opposite to that which he thought he would obtain by the excitation of the sympathetic; the temperature went down instead of up. This erroneous induction was, however, the point of departure of an admirable discovery, that of vaso-motors. Claude Bernard was wise enough not to persist in his hypothesis, but to adapt himself to the facts, *se subjungere rebus*. Throughout the whole of his glorious life he remained faithful to the teaching of Magendie, his illustrious master. Magendie was delighted when experiment gave a result contrary to what he was expecting. "Well!" he used to say, "I was mistaken, but it is much more interesting than if I had succeeded. I foresaw, as probable, a logical orthodox fact, which everybody might expect; and it is just the contrary that happens. There is therefore a new phenomenon, so much the more important as it was so little expected." And Magendie did not hide his satisfaction at having run aground.

(3) Once it happened to me that I made a hypothesis that was verified, and I saw my hypothesis and my experiment, amplified by clever physiologists and great doctors, undergo considerable development. It was that of serum therapy, one of the principal conquests of modern therapeutics. So I may be permitted to lay stress on it. For I truly believe that the genesis of a discovery constitutes the most curious part of its history.

Our great physiologist Chauveau had shown that French sheep die from anthrax (*Bacillus anthracis*) when they are inoculated with anthrax blood; but that Algerian sheep, after being infected by the same blood, do not die. Why this difference? In my course of physiology, in 1883, as I was talking of the little-known extractive substances of the blood, I suggested that it might be one of these extractive substances, still mysterious, existing in the blood of Algerian sheep, which opposed the growth of the anthrax bacilli. "Who knows," I used to say, "whether by injecting the blood of an Algerian sheep into a French sheep, immunity against anthrax will not be conferred upon the latter?" I advised

my students and my assistants to try the experiment.

We had no sheep in our laboratories, so that for five years my projected experiment remained in the nascent stage. And it was by an absolutely different path that I returned to it.

Among the dogs which were brought to the laboratory, there was found one which had a cancerous unopened tumour. The question was then being asked, as it is still being asked to-day, whether microbes were not the cause of cancer, so with my friend Héricourt I tried to find some microbe in this cancer, and indeed we managed to isolate one and cultivate it. Naturally, we injected it, hoping to reproduce the same cancer in other dogs, but the failure was complete. It certainly developed a tumor, but only a sort of abscess, which sometimes was reabsorbed and sometimes became purulent. With rabbits, this injected microbe produced a great œdematous tumor, and the animal died in three or four days. On the other hand, dogs, although ill for some days, did not die. And then I thought of using this microbe, mortal for the rabbit, not mortal for the dog, and making the experiment which

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I had spoken of in my course, five years previously. "*Since the dog is immune, by injecting the dog's blood into rabbits, will not they also be rendered immune?*"

At first we encountered a sinister check; for rabbits, after a venous injection, could not stand the dog's blood. At this period (i.e. in 1886) no one had thought of serum, neither myself nor other physiologists. It was the complete blood that we then injected, and all our rabbits died as soon as a few drops had been introduced. Then I thought of overcoming the difficulty by injecting the dog's blood not into the veins, but into the peritoneum of the rabbit. After this peritoneal transfusion, even when abundant, the rabbit did not die. Well, it turned out that the rabbits which had received the dog's blood in the peritoneum resisted our microbe much longer than normal rabbits.

We soon discovered another fact, of extreme importance. When we injected the blood of a normal dog, the rabbit ended by dying of microbial infection; but when we injected the blood of a dog infected by our microbe and

cured, the microbe had no longer any hold on the rabbit so transfused, and it survived.

Consequently, by injecting blood, one communicates to the injected animal the immunities possessed by the animal whose blood is injected. That is the whole principle of serum therapy.

And immediately we grasped the vast consequences of the discovery. Then we committed an error, a lamentable error, doubtless very excusable, but an error none the less.

Héricourt and myself, after the rigorous statement of the fact (immunity by the blood of immune animals), dreamed of applying it to a disease other than this very special infection of the rabbit. And I remember yet, as if it had been yesterday, the long conversation—for us historic—that we then had. To what malady must we apply hematotherapy—it was not yet called serum therapy—diphtheria, anthrax, or tuberculosis? There were arguments for and against each. Considering the state of science in 1887, and the absolute novelty of the hematotherapeutic method, we had no serious motive for choosing diphtheria rather than tuberculosis, or tuber-

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culosis rather than diphtheria. We decided on tuberculosis.

And this choice was unfortunate; for the serum therapy of tuberculosis is doubtful, whilst the serum therapy of diphtheria gives marvellous results; as, two years later, Behring showed in an admirable piece of work.*

So one must admit the part played by chance in scientific things, as in everything else of this world, and I ask myself again by what divination we could have been expected to foresee that serum therapy would cure diphtheria, while tuberculosis it would not cure?

(4) It was chance alone that permitted Héricourt and myself to discover *zomothérapie* [raw meat treatment], that is to say, the treatment of tuberculosis by the ingestion of the juice of raw meat: our perspicacity had no great share in it.

Our studies on the serum therapy of tuberculosis went on endlessly: we attempted various

* Behring never had the courage to recognize that we had discovered, two years before himself, the principle of serum therapy, and that we had, in 1890, a year before him, made the first therapeutic injection of serum on man.

treatments for experimental tuberculosis, various vaccinations, various diets, and we devoted ten years to our studies. They were sterile, I am not at all afraid to admit that. Neither creosote, nor arsenic, nor iodine, nor uric acid, nor dieting would give results; no more than would vaccinations with various tuberculous or weakened microbes. But, one day, after having arranged our experimental programme so that there were three dogs for each special treatment, it was found that we had a dog too many, sixteen instead of fifteen! Then, not knowing what to do with this sixteenth dog, I conceived the idea of feeding it on raw meat.

At the end of a month and a half, the fifteen dogs were dead: all without exception. The sixteenth alone had survived; this was the dog nourished on raw meat. I thought then that we had made a mistake and that it had not been inoculated with the tubercular virus. But no! we could see that it had on its paw the little scar, proof of the injection.

Happily, I recommenced the experiment. But it was—I admit—without great conviction, for our blindness is such that unforeseen facts

have to force our hand to make themselves accepted. And soon it was demonstrated to us that tubercular dogs nourished otherwise than on raw meat succumbed, whilst those nourished on raw meat resisted. Not only did they resist, but they retained robustness, vigour, marvellous health.

Then, but after the event, I understood. I ought to have foreseen it. But neither I, nor anyone, had dreamt of it, until the moment when experiment, far superior to our poor imagination, began to speak so as to make us understand. In all Nature no living things are nourished on cooked foods. Cooked meat, therefore, is not a natural food. Hence this feeding, being in a sort of way abnormal, may not be the best. And the reason for that is easily understood, since the albumens which constitute raw meat are easily transformable into living muscle, whereas that transformation is not so easy if they have been broken up by heat. Therefore, by feeding dogs on raw meat, one is returning to the natural food, and giving them sufficient strength to resist tuberculosis. But this very proper reasoning, childish in its simplicity, we only arrived at *after*

experiment, and I recognize the fact in all humility.

The efficacy of raw meat having been once established, the experiments still to be made were all indicated. They were not very difficult. By a few decisive examples we could prove that the juice of meat was the therapeutically active part of muscular flesh.

(5) The history of anaphylaxy, which has had such good fortune, is another excellent example for showing how much more fruitful experiment is than speculation. Never would I have supposed anaphylaxy possible. Even when it presented itself to us, my dear friend P. Portier, with whom I was working, showed himself entirely rebellious about it. It was *in spite of myself* that I managed to discover *l'anaphylaxie* [the converse of immunity, hypersensitivity to specific disease].

Here are the facts. On the yacht of Prince Albert of Monaco, P. Portier and myself, following the advice of the Prince and Dr. Richard, made some experiments on the *Physalidæ*, *Celenterata* of tropical seas, whose tentacles are

venomous. And as there were no Physalidæ in our climate, but only Actinia, which are very common on all our coasts and which in certain respects resemble Physalidæ, I had Actinia brought, and from them extracted a poison of which I studied the effects. It was necessary to find the toxic dose: let us call it 1; so that dogs which had received less than 1 should survive after some days of sickness. For convenience I kept them in the laboratory in order to give them another injection later, for, at the end of three or four weeks, they were absolutely cured.

And then appeared an extraordinary fact, now banal enough, which at first I had enormous difficulty in believing. On these cured dogs the feeble dose of 0.1 became immediately fatal. To make sure there was no mistake, I repeated the critical experiment (*experimentum crucis*) on a great fine vigorous dog, injected a month previously, which I had called "Neptune." At the dose of 0.1, in a few minutes, Neptune was defunct. It was so much the more surprising as even the dose of 1 kills only slowly, at the end of two or three days.

Of course, the experiment was repeated,

modified, codified. It turned out to be the foundation of "anaphylaxie." As it was a new fact, I wished to give it a new name—a name which, like the word "zomothérapie" and the word "polypnée," have passed into the ordinary scientific vocabulary. These three new words signify three new things.

(6) Sometimes the preconceived idea, the working hypothesis, *is almost true as it stands*, but it has to be verified and corrected by experiment. Thus I said one day to my friend Hanriot: "Chloral is a hypnotic; so is lactic acid; let us see what chloral lactate will do—a combination of chloral and lactic acid. It ought to be a marvellous hypnotic." But alas, no! chloral lactate produced violent and terrible convulsions. Nevertheless, we were not discouraged. By combining chloral with an isomer of lactic acid, glucose, we obtained chloral-glucose which we named chloralose, a very interesting substance that can be employed as a hypnotic in human therapy, and which, meanwhile, is commonly used in laboratories to-day as an anæsthetic for animals.

But I must not prolong this story of the hesitations through which I passed in my various researches. If I have recounted them here, it has only been in order to show to what extent experiment is more fertile than imagination. The merit of the experimenter consists above all things in observing everything that happens, noticing the smallest details, in not being satisfied with plausible and unconfirmed conclusions; although too often our intellectual idleness adopts them without examination.

Just one word to end this chapter—too personal, perhaps. It is a question of my method of working. I do not pretend that it is perfect, but I think that it has some merits, for it enables many experiments to be made rapidly. If I may employ a trivial comparison—a fisherman, in order to catch fish in a district of which he is rather ignorant, casts his line in various parts of the river. In the same way, it is necessary to try right and left all manner of experiments, one of which may perhaps be fruitful. But in order to do much, one must not delay too long over any one of these experiments.

A first rough hasty one should be attempted, to see if it gives indication of immediate results. It would not be wise to apply laborious and complicated instruments to this attempt: one must find out, forthwith and very quickly, whether it is worthy of perseverance. If the result is nil, one does not continue, and will not have lost much time. But if one is successful, this first success is insufficient. Then ensues a long period of work, demanding a technique more and more perfect, instruments more and more precise. It is necessary to repeat, and again repeat, changing all manner of conditions.

Moreover, it is necessary always to apply the most searching criticism. In so far as one has been hasty, elementary, unprecise at the beginning, one must redouble precision later.

No one has the right to encumber science with premature assertions. I don't know which physiologist it was who said: "An erroneous affirmation which has taken a day to construct, requires sometimes twenty years of work to overthrow." In his laboratory, before publication, the savant can be, and even ought to be, very rash, very rapid; but when it is a ques-

tion of publication, he must be scrupulous in the extreme.

And I allow myself often to formulate the precept in this form: "Be as bold in the conception of hypotheses as rigorous in their demonstration."*

* I have said it already; but intentionally I repeat myself; for it is a precept, sound, imperative and fruitful.

Chapter XI

ON PRECOCITY

LIKE some artists, a few savants have exhibited extraordinary precocity. There have been some who, even while still children, scarcely adolescent, showed profound genius before which we remain dumfounded.

They are almost always mathematicians.

Perhaps the most remarkable example is that of our great Pascal, who at the age of eleven, according to his father and Jacqueline his sister, reconstructed the first books of Euclid, without having read any of them, by drawing circles and lines. One will never quite know to what extent this precocity is legendary. But certainly not legendary are the many cases of precocious mathematical genius brilliantly illustrated in the persons of Gauss, Darboux, Bertrand, and Galois.

Évariste Galois (1811-32), who died when twenty-one, killed in a stupid duel, is a singular case among these singular cases. At the age of

seventeen, while still at college, he thought out a new theory of algebraic equations, and sent to the Académie des Sciences a paper which has unfortunately disappeared. At the age of nineteen, he published a memoir containing new and profound conceptions, and among his papers was found a work (not published till 1846) which exhibits immense progress in analysis. Galois was, so mathematicians say, one of the most original mathematical geniuses of all time: and he was only twenty! If he was rejected at l'École Polytechnique, it was because there was put to him a question which he considered ridiculous and to which he would not deign to reply.

J. Bertrand obtained an age exemption from the entrance examination at l'École Polytechnique, and he stupefied his examiners. William Thomson, at fifteen, wrote an astonishing memoir on the shape of the earth, where he handled in an original manner the most difficult theories of celestial mechanics and kinematics. Arago, at the age of twenty-three, was a member of the Académie des Sciences.

Nearly every year, not in France alone but in other countries also, there is found some

schoolboy, fifteen or sixteen years of age, who, almost as if it were a game, deals with the most difficult problems of analysis, and sometimes discovers new solutions. For those unfortunates (like myself, alas!) who in spite of all their willingness, and in spite of repeated efforts, manage painfully and indifferently to absorb the first elements of mathematical science, this precocious and deep genius remains a great mystery which is both puzzling and humiliating.

In sciences other than mathematics, precocity is much more exceptional. In fact, when it is a question of physics, or chemistry, or biology, the savant is forced to observe much, to read much, to experiment much. It is laborious; it is hard. *Ars longa*, Hippocrates used to say. A chemist cannot find, already in his mind, the laws and the phenomena which govern matter. Whereas the geometrician takes a pen, a sheet of paper, and, without books, without documents, develops the truths which unroll before his genius. He improvises things new and fertile, for his mathematical mind permits him, in a relatively short time, to know almost anything that has been done by his predecessors. But

savants who are not mathematicians have need of longer initiation. A laboriously acquired technique is necessary; and to know all that has been done by the masters requires much time. The chemist, the physicist, the geologist, move in a material world, less tractable than the immaterial world of mathematical thought. It takes some years to learn how to manage efficiently a galvanometer, a polarimeter, a microscope.

The mathematician encounters no obstacles other than those of thought; while the biologist and the physicist are obliged to conform to the hard reality of things, up to the limits which the imperfection of our senses assign to us. The infinitely little, with which the mathematician plays, is inaccessible to the chemist and to the biologist, for though a microbe is very small, it is not by any means infinitely small, any more than are the interference bands of two luminous vibrations, or the lines of helium spectra.

The material difficulties presented by science render any surprising precocities almost impossible in non-mathematical sciences. One could recognize the great intelligence, but not the genius, of Lavoisier, by the memoir which

he published when twenty-one on sulphate of lime. Laënnec discovered auscultation at the age of twenty-five. But this discovery, which after all was only a happy idea, was only perfected and fructified by long labour.

In the sciences which are not mathematical, precocious and fruitful discoveries are therefore exceptional. One can, however, recognize merit even in a very young boy, from his successes at school; and can consequently predict that if he follows a scientific career, that career will be brilliant. Nothing is more stupid, in this respect, than the opinion so often expressed, that successes at school do not count. What an error! Certainly many brilliant schoolboys show afterwards only an insignificant mediocrity; but generally those who later become illustrious have shown, from the first, by their aptitude for history, science, literature, languages, that they were superior to their contemporaries. Shall I remind you that Berthelot had *le prix d'honneur* for philosophy?

To sum up; for mathematicians, as for musicians, painters, and poets, the period of great intellectual production begins usually at

the age of twenty-five, but for other savants the zenith is oftener thirty-five. True, there are so many exceptions that I am almost afraid to lay down a rule. Anyhow, it is very rarely that a great mathematician has not at the age of twenty-five given some proof of his genius, or that a great naturalist has done anything really striking before thirty-five.

As to the moment when the power of production and discovery wanes, the diversities are so great that no law can be indicated. Generally speaking, originality declines rapidly with age: it is sad, but nevertheless true. When one has passed the age of fifty, one rarely has new ideas; one just repeats. Victor Hugo, Voltaire, Goethe, are sublime exceptions.

One might suppose that this slackening of intellectual power is due to the anxieties of life, to family cares, to parasitic occupations that tend immoderately to increase. One might also invoke a strengthening of the critical faculty. But these are only extenuating circumstances. Men of over fifty must resign themselves to it. Their power of imagination, after that age, always decreases, save with rare exceptions, and soon disappears.

THE SAVANT

I am not speaking of savants endowed simply with honest mediocrity. These last become neither better nor worse with age : they merely prolong their mediocrity.

Chapter XII

ON THE METHOD OF WORK

WHEN it is a question of deciding about undertaking some research, one may hesitate between two courses.

Either one may enter on a difficult arduous subject, which may lead to no results, make no return for labour; so that after several months, perhaps several years of work, if success is not forthcoming, only negative results are arrived at, although if one did happen to succeed, the success would be very great;—but one can never be certain of success.

Or one can take an easy elementary subject, which will certainly give some results, whatever happens, but the importance of which will not be remarkable; for numerous savants have already traced the outline or frame in which to place facts which, though new, are of secondary importance.

For example, if a physiologist wishes to study the toxic character of salts of yttrium, he is sure

to arrive at some result or other, worthy of being inscribed in the annals of Science; and he is sure, too, that these results will be new, since no work has yet been undertaken on the physiological effects of salts of yttrium. All the same, it can never be very exciting to learn that sulphate of yttrium is a poison when the dose is 0.25 or 0.75 of a gramme; that for the rabbit it is more toxic than for the dog, less toxic than for the frog; and that the heart stops before respiration ceases. These precise facts are not null, but general physiology will hardly be advanced by them. For, as Aristotle said, without generalization there is no science.

On the other hand, if one has sought to study the modifications that important cerebral lesions produce in heredity, one is undertaking a prodigiously long and difficult task, bristling with extreme technical difficulties. But if one does succeed in discovering a new law, the result must be remarkable.

Truth to tell, this distinction, between easy unfruitful problems and hard problems rich in consequences, is theoretical rather than real. For if the experimenter has original ideas, he

will always find some means of bringing them to light; he will be able to transform a subordinate question into a fundamental one. If, on the contrary, he is of ordinary intelligence, he will reduce a fundamental question to a trivial one.

When one begins some research or other, even though very modest in appearance, one can have unlimited hope, for who can tell what may result from this work? "Will it be gold, table, or slop-pail?" Experiment first; you will know afterwards. Remind yourself always that experimentation cannot but be fruitful. Attend to everything, watch everything, observe the conditions, the modifications; and above everything, allow yourself to be led by the facts. The harvest will be sometimes more abundant than the sower thinks.

Finally, here is a precept which I consider fundamental, essential—so fundamental and essential that it dominates all others:—

"Young man," I would say, "if you would discover a new truth, do not seek to know what use will be made of it. Do not ask in what way medicine or commerce or industry may

profit by the discovery; for if you do, you will discover nothing at all. You wish to find a solution to a problem that you consider important: tackle the problem without worrying about the consequences. Attack the question on its simplest side. Do not be stopped by the criticisms of journalists, hygienists, engineers, chemists, doctors. Let them talk. Go straight to the problem by the shortest road. Leave to practitioners the cumbersome care of consequences and industrial applications. *Veritas lucet ipsa per se*. Truth is sufficient unto itself.

“Understand this clearly; that the right method, even for obtaining a useful practical result, is not to worry about the practice, but to concentrate intensely on pure investigation, without being hampered by any parasitic considerations other than whatever conduces to greater facility for research.

“You have before you one object only, one aim that must be attained, one truth that it is necessary to know. Then take the best road for arriving there, even if you are criticized or blamed or ignored by doctors, by engineers, by manufacturers.”

Where should we be if Galvani, instead of touching the legs of his frogs with iron and copper, had wished to construct a telephone? Soubeiran, discovering methyl tri-chloride, which he called chloroform, was by no means seeking an anæsthetic, any more than Röntgen was endeavouring to facilitate surgical operations.

I might compare our ignorance to the impotence of a man before an enormous block of metal—hard, resisting, almost unassailable—inside which he yet feels sure are treasures which might be brought to light. He knows that those treasures are there, and that they would be useful, say, for curing sick people, or for quick transport along the surface of the planet, or for improving the material conditions of human existence. But before all else he must succeed in breaking into the enormous block, must make an opening in that resisting mass. Such a man would be perfectly absurd if, instead of attacking the metal by whatever means appeared most efficacious, he allowed himself to be diverted by other considerations, and asked himself: “Am I going to cure a malady? am I going to traverse distances more quickly? am I going to improve

the well-being of my fellows? ” No! certainly no! He will only arrive at the happy outcome of a truth conquered, if, while conquering truth, he refrains from thinking of consequences, Truth can only be attained by taking the easiest road to it.

Yet far be from me the foolish idea of denying that there is an industrial science, and that devising the best technical processes for lavish output is a negligible thing. But we are here on the borderland of science and practice. When the metallurgist seeks to know the best proportions of iron and silicon suitable for a given kind of steel, he employs methods which are precise, delicate, essentially scientific, in order to resolve this important problem; but that is no longer pure science, it is applied science; for then it is not simply a question of *knowing*, it is above all a question of obtaining under industrial and economic conditions a very resistant steel. Now economy has nothing to do with science. P. Curie, preparing and discovering radium, did not halt in the research under the pretext that the price of radium would attain unbelievable heights.

ON THE METHOD OF WORK

In other words, the interest of a research is not in its practical applications. That will always come, sooner or later, in its own time; for thousands of speculators will fall upon that. The immense indefinite interest of a scientific investigation is in the unforeseen result that may perhaps be brought to light, and especially in the extent of the numerous horizons that may be displayed.

Unfortunately—or perhaps fortunately—our perspicacity can never foresee the greatness of the results likely to be obtained. Neither Thales, nor Ampère, nor Galvani, nor Volta, suspected that the great and perhaps the only force in the material world was the atom of electricity; and it is precisely because they remained in the domain of pure science that they have become mighty pioneers in human industry.

The greatest difficulty in a prolonged scientific research is to know to what limits perseverance in this research must be maintained. At the end of how much time should one feel discouraged, if after weeks or months one has obtained only contradictory results? When one makes the technique more precise, the inquiry

may become more difficult, and uncertainties go on increasing. Yet we may feel that we have hold of a fruitful idea, which will probably be verified if we continue. But ought we to continue? The labour may be sterile. How is one to know? On the other hand, to cry a halt, to run aground close to port,—that is hard. Who knows whether another savant, gifted with superior tenacity, will not solve this fine problem, and consequently garner the harvest of all our long effort?

We are bound to ask, is the problem soluble? For after all, there is nothing to prove that it can be solved, either now or later. On the last page of illustrated journals, chess problems are submitted to the ingenuity of readers. They are certain, these readers, that there is a solution. They would therefore be wrong to be discouraged; they can persevere, for with talent and application, they can be sure of a solution. But with the problems of nature, it is not so. Nothing enables us to affirm that mankind can explain such and such a phenomenon. Perhaps the cause of these facts will remain always impenetrable. Consequently, it is surely wiser not to be too persistent?

ON THE METHOD OF WORK

What advice can we give? Which side shall we take? Alas! There are in such a case no rules, no precepts, no principles. To know when to persevere, to know when to stop,—that is the gift of talent, almost of genius.

If young men would follow the right path, they should study in early youth the discoveries made by the masters; they should examine by what precise deductions, by what audacious inductions, the admirable edifice of contemporary science has been built up.

Afterwards they can abandon themselves to their own inspiration. But let their inspiration be preceded by long reflection.

After all, I rather think that in general one is more likely to err through defect than through excess of perseverance.

Chapter XIII

CONCLUSION: WHAT OUGHT TO BE DONE FOR SAVANTS

AND now I have arrived at the most important part, perhaps the only important part, of this little work. And that is the formal earnest irrefutable conclusion, a conclusion which I utter with ardent conviction, and in which I shall put all the passion that my old heart is capable of:

The welfare of mankind depends on the progress of civilization.

For a long time I thought that this proposition was a platitude, a truism so self-evident that one would be ashamed to develop it. But no! it is not at all self-evident; for it has been maintained that civilization brings into our life elements of misfortune so heavy that the whole serenity of normal human life will perhaps be for ever disturbed by it. J. J. Rousseau said that civilization rendered men wicked. Certain pessimists declare that it makes them unhappy.

Now, if there is dispute about it, that must be because there is not agreement about the word "civilization."

Is it the development of the monstrous military agglomerations, scientifically organized for pillage and massacre, in which entire nations become entangled? Is it machinery with its gigantic factories, its lairs where thousands of young workpeople, blacksmiths, weavers, perform without intermission the same unintelligent and arduous toil? Is it the disordered luxury of great cities, where provocative and cynical debauchery displays itself, flaunting its ostentation in the faces of the poor? Is it the extension of the great banking establishments, this unfortunate international finance, this greedy, tyrannical, all-powerful plutocracy, which crushes modest lives?

Undoubtedly civilization sometimes involves these execrable consequences. Like everything else that is human, it can do harm or it can do good. I know all the harm that it has done; but I know also that though it has done harm, it has done yet more good.

What, then, is civilization? I am not going

to say, as did some humorist, that it is measured by the quantity of soap and postage stamps used per inhabitant. This picturesque definition is inadequate, and I would rather sum up what appears to me to be the principal element of civilization by saying that it is *knowledge*.

To be civilized, it is necessary to know something of the forces which surround us. The better one knows them, the more is one civilized. A savage understands nothing of the universe; and we—well, we understand a little more, but only a little. To know that smallpox is a microbic disease, and not the vengeance or spite of a destroying angel—that is civilization. To understand that an eclipse of the moon is due to the interception of the solar rays by the terrestrial globe, and not to the devouring jaw of a dragon—that is to emerge a little from barbarism. To ascertain that air has weight, and is composed of an admixture of two different gases—that is a stage in intellectual progress.

Often enough the knowledge of things suggests some possible utilization of these things, some adaptation to our needs. When one knows

that smallpox is due to a microbe, and that this microbe can no longer infect our organism when that organism has been protected by another microbe, that is a contribution to civilization. First, because it is a fragment of the knowledge of things, and secondly, because, making use of this knowledge, we can provide against smallpox and thus prevent cruel suffering.

Let us make a very simple hypothesis. If to-day, in 1926, we were to know all the secrets that men will know in the year 2026, a century hence, is it not evident that we should be more civilized than we are. Even the men of 1926 are more civilized than were the contemporaries of da Vinci; while the contemporaries of Leonardo were more civilized than the soldiers of Agamemnon.

Truly, civilization does not altogether ensure happiness; too often it has happened that instead of profiting from growth in knowledge, men have mis-employed the resources brought to them through the agency of prolonged scientific work. If aeroplanes were to be used entirely for bombarding towns, aviation would be a disastrous discovery. If the progress of chemistry

consisted only in producing still more noxious gases capable of destroying a regiment in a few minutes, then chemistry would be an accursed science. Therefore civilization, in the legitimate meaning of this word—a better condition for human life—does not consist only in the knowledge of things, nor even in their useful employment. Something else is necessary: and that something else is, if you will (although this phrase has been abused), a sort of *moral order*, the notions of corporate welfare and human fraternity; a due regard to right.

So our proposition: *the welfare of mankind depends on the progress of knowledge*, is absolutely true, but on condition that this essential correction is added, that the welfare of man does not depend *solely* on the progress of knowledge.

Without knowledge of things, there is no civilization; there is no well-being; savagery would be dominant in all its brutality. But knowledge is not sufficient, it is necessary that intellectual development shall be employed for good and not for evil. In other words, science is a necessary condition for human welfare, *but not a sufficient condition*.

To understand something, be it ever so little, of the universe, is indispensable to the greatest happiness, or to the least unhappiness of man. It is scarcely decent to defend this platitude. Admirers of paradox may claim that humanity was happier in the time of the Crusades, because the Christian faith was then supreme; or in the period of Louis XIV, because kings were then regarded as divine beings. But if these admirers were forced to live, feed, clothe, and travel, as in the age of Bernard the Hermit or of Louis XIV, these unfortunate admirers would grumble and rebel. If we are less uncomfortable than our fathers, that is because science has made progress. All progress in science is progress in civilization, and consequently contributes to the welfare of man.

Science advances with disconcerting rapidity, and yet she is still very young. Thales and Archimedes, in spite of all their genius, knew nothing of what is taught to-day in the primary school. The most ignorant of university students knows a quantity of things of which Galileo was completely ignorant. From Franklin to Einstein, there are scarcely 150 years; but in 150

years, what giant steps! What a transformation of all our conceptions! There was then no palæontology, no bacteriology, no photography, no aviation, no railroads, no spectrum analysis. The scientific epoch of humanity is scarcely more than 150 years old. 150 years! Four human generations! Nothing at all!

Events move rapidly. We advance towards the knowledge of things in geometrical, not arithmetical, progression. We are therefore able to admit that some day, thanks to the growing wealth of scientific acquisition, man will exercise a sovereign dominance over all matter, inorganic or living, hostile or favourable—in fact over everything that surrounds him.

But science gives more than this supreme intellectual joy of knowledge. It brings about the unforeseen, the unexpected; it reveals some of these marvellous phenomena which vibrate all around us, and which we are too ignorant to apprehend. Our feeble intelligence is not able to penetrate to the truths embodied in things: it is incapable of imagining even a fragment of what science is going one day to unveil. Who could have foreseen, fifty years ago, the tele-

phone, wireless telegraphy, aviation, vaccination, serotherapy, chemical synthesis? And we are only at the beginning. Our grandchildren will see wonderful things which it is impossible for us to imagine.

To neglect science is to exclude fair hope, to condemn ourselves to live a uniform monotonous existence.

I wish I could impress on the minds of those who read this, my profound conviction that science will transform the state of humanity from top to bottom. But alas! poor mankind is powerless to imagine anything other than what is. We are all more or less riveted to the present, incapable of realizing that all will be changed, and that the present state of things will not be eternal.

Even if we cannot always retain these sublime and magnificent hopes, we can straightway, from this moment, be assured that many miseries, and especially some of the most cruel—that is to say, the diseases, scourges of all existence—will be effectively combatted and dominated, perhaps suppressed, by science. If man, stupid and blind man, had devoted to

science the tenth, or even the hundreth, aye, or even the thousandth part, of the intellectual and material forces which he has sunk in the abyss of war, the world would be quite other than the brutal and ferocious world in which we live. Human society would differ from actual society as much as the mentality of a Cambridge professor differs from the mentality of a Papuan or a Hottentot.

But, after all, it may be absurd to advocate such wisdom! Let man therefore abandon himself to the great joy, ancestral and exciting, of military orgies—battles, massacres, explosions, sinkings, plunderings. Since such is his pleasure, we must not dream of depriving him of it. Even then, however, it might be possible to keep a little place for science—but that is just what he does not do.

The madness and stupidity of men are so vast that they behave as if absolutely ignorant of the fertile province of science. They dare not claim that science is useless, they do not go so far as that; but they act as if they had made this proclamation, for they relegate the pursuit of science to the background.

It is to throw scorn and disdain upon science, not to give to savants the place they ought to occupy in the country, the State, in society. For, in the last resort, we cannot separate science and savants. Science cannot develop by itself. Nature guards her secrets jealously: it is necessary to lay violent siege to her for a long time to discover a single one of them, however small it be.

What patience is necessary! what perseverance! what intelligence! what genius even! If there were no savants in the world, if the demon of research did not invade the souls of some young men, our European community would become fossilized by trade and war. There would be soldiers and officers, bankers and clerks, labourers, miners, engineers, doctors, grocers, washerwomen, sailors; but all would continue, imperturbably, along the same old lines. There would be no innovation, no progress. Doctors would repeat the same prescriptions. Engineers would construct the same bridges. Grocers would sell the same provisions. Soldiers would fight with the same weapons.

Or rather, decadence would come quickly;

for a society which does not progress is fatally condemned to rapid regression.

And this brings me to a second proposition, quite as conspicuous as the first. Neither more nor less than this:

The progress of science depends upon savants.

That again is a truism, again a platitude. What care I for that! It is not a question of enunciating a paradox; what I am saying is a startling truth, that ought to shine out by itself; but so cruelly misconceived has it been that it is necessary, if possible, to bring it out into stronger light.

In order that the savant may be able to work at science, it is essential first that he be able to live. One cannot ask men, however disinterested they may be, to take up a calling which condemns them to hunger. Now, actually, the calling of savant does not enable one to live. Nowhere, save perhaps in America, thanks to generous and intelligent millionaires, has society, so-called civilized society, contributed even moderate emolument to the men, young or old, who give themselves up to pure scientific research and so advance civilization.

WHAT OUGHT TO BE DONE FOR SAVANTS

Certainly, in the laboratories of Universities, Schools, Institutes of Chemistry, of Bacteriology, of Botany, Directors are appointed who are eminent savants. But these savants are paid as professors, not as savants. They could perfectly well refrain from all personal research. Provided they give their regular courses, they lay themselves open to no reproach. I could cite a distinguished and zealous professor who has produced nothing original. He was within his rights. He was commissioned to teach old discoveries, not to make new ones.

Now teaching, useful and necessary as it is, is not the whole of science. It is indispensable to teach young people how to measure the speed of light, to learn in what combinations carbon unites with nitrogen, or how excitation of the pneumogastric nerve makes the heart beat slower. But it is not by means of lessons, however perfect, on the speed of light, the composition of cyanogen, and the excitation of the pneumogastric nerve that new and unforeseen discoveries will be made. One is only marking time by teaching in 1926, correctly and even eloquently, what was already taught in 1920, in 1910, in 1900. It is necessary

to go forward, for the discoveries to be made are enormously more important than the discoveries already made.

If we wish for progress, savants must be given means of working. Not only must they be assured of laboratories equipped with indispensable apparatus; but above all they must be assured, by suitable emoluments, of a livelihood. They must also be given assistants who are amply remunerated. In fact, scientific institutions must be created independent and autonomous, whose sole function will be the disinterested search for truth.

Engineers, doctors, lawyers, professors, apothecaries, officers, bankers have professions which enable them to live. But, well informed as they are, they are not savants, for their calling absorbs the best part of their time. They can therefore only work at science as something extra, in their leisure moments.

Now science demands exclusive sacrifice. It admits of no sharing. It requires from devoted individuals the consecration of their whole existence, their whole intelligence, their whole labour.

Therefore, because of the inherent uncertainty of all research, and the inability of this research to enrich its devotees, savants can only pursue their labours if they are given means of providing food and housing, and also of supplying themselves with sufficient working instruments.

Is it too utopian a proposition to institute a body of savants whose sole object shall be research?

If this reform seems too much to expect from our conservative and weak timidity, then at least certain professors could be released from teaching, and could be maintained in their laboratories.

It is not a question of abolishing courses and lessons. That would be foolish, almost criminal. It is simply a question of creating, along with pedagogic chairs, institutes for research which confer no degrees, and know nothing of lectures, lessons, courses, diplomas. The savants who, with their assistant helpers, direct these laboratories, should have no function beyond that of pure research.

If this prodigiously easy reform were resolved upon, it would not entail a very heavy expen-

diture. In any case, it would be an exceedingly profitable investment. It is by means of science applied to industry that nations become prosperous; for science brings them not glory alone, but also wealth.

Therefore the nation ought to provide a livelihood for savants, under pain of being extinguished in mediocrity.

Assuredly, some savants will always exist. Original genius will not disappear. Great discoveries have emanated from miserable laboratories, mean hovels, devoid of everything. Pasteur, Würtz, Berthelot, Claude Bernard, had but the poorest resources at their disposal, and yet they conquered the world. A wealth of laboratory equipment does not ensure discovery. That needs hard work, perseverance, and genius in the man who uses it.

We cannot enkindle genius; but at least we can, and we must, give to the *élite* among our young men the opportunity of becoming illustrious, if they possess the divine creative spark.

It is in them that all my hopes rest.

And I shall not cease to repeat, with all the

energy of a profound conviction that reflection has developed:

The future and the happiness of humanity depend on science.

So much the worse for society if it fails to apprehend this outstanding truth.



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